

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PROPOSED APPROPRIATION LANGUAGE

For necessary expenses in carrying out fossil energy research and development activities, under the authority of the Department of Energy Organization Act (Public Law 95-91), including the acquisition of interest, including defeasible and equitable interests in any real property or any facility or for plant or facility acquisition or expansion, and for conducting inquiries, technological investigations and research concerning the extraction, processing, use, and disposal of mineral substances without objectionable social and environmental costs (30 U.S.C. 3, 1602, and 1603), performed under the minerals and materials science programs at the Albany Research Center in Oregon [\$384,056,000], \$364,000,000 to remain available until expended: of which \$24,000,000 shall be derived by transfer from available unobligated balances in the Biomass Energy Development Account: Provided, that no part of the sum herein made available shall be used for the field testing of nuclear explosives in the recovery of oil and gas.

Explanation of Change

Reflects a total FY 2000 budget request of \$364,000,000 of which \$24,000,000 is derived from the Biomass Energy Development Account.

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(Tabular dollars in thousands, Narrative in whole dollars)

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

Program Mission

The mission of the Fossil Energy (FE) Research and Development (R&D) program is to enhance U.S. economic and energy security by: (1) managing and performing energy-related research that promotes the efficient and environmentally sound production and use of fossil fuels; (2) partnering with industry and others to advance clean and efficient fossil energy technologies toward commercialization in the U.S. and international markets, and: (3) supporting the development of information and policy options that benefit the public by ensuring access to adequate supplies of affordable and clean energy.

Program Overview

The U.S. is reliant on fossil fuels for about 85% of the energy it consumes. Many forecast that relatively low fossil fuel prices and high U.S. reliance on these fuels will continue for decades. Accordingly, a key goal of the Department's fossil energy activities is to ensure that economic benefits from market-priced fossil fuels and a strong domestic industry that creates export-related jobs do not come with unacceptable environmental costs or energy security risks.

To be successful, Federally funded and developed technologies and related analysis need to be transferred into commercial applications. This will be accomplished through joint partnerships with industry utilizing a variety of mechanisms including cost-shared contracts, targeted outreach activities, and cooperative research and development agreements with the Department's Federal Energy Technology Center and National Laboratories.

Coal

The FY 2000 request for Coal activities is \$122.4 million, and includes R&D related to coal power systems, coal-derived fuels, and advanced research. This program responds to the energy and environmental demands of the post-2000 domestic market, including

increasing international pressure to reduce greenhouse gas emissions, and helps U.S. industry to respond to a currently large and growing export market, while contributing to national energy security. In response to these priorities, the coal program is focused on three goals. The first is to develop progressively higher efficiency and cleaner power generation systems with 10-20% lower busbar electricity costs, which can ultimately evolve into a "Vision 21" fleet of new power and energy plants with near zero levels (including CO₂) of pollutants. The second goal is to develop super-clean emission control systems for SO₂, NO_x (70% to 90% reduction at below today's cost), air toxics (90% reduction), and particulate matter that can be applied to existing plants. The third goal is to develop economically competitive technologies for the production of alternative transportation fuels and chemicals.

Significant progress towards achieving these goals will be made in FY 2000 through a number of ongoing projects in the Clean Coal Technology Demonstration Program. Three advanced integrated gasification combined cycle (IGCC) facilities will be operating to provide clean power with new technology. A second generation pressurized circulating fluidized bed combustion facility will be under construction and the data needed to evaluate the comparative merits of nineteen advanced environmental control devices just recently demonstrated will be available. Finally, the first demonstration plant to produce alternative transportation fuels and chemicals by means of the innovative liquid phase methanol process has started operation, reaching design production within a few days of initial operation. Subsystems and problem-solving critical to the Clean Coal Technology Program projects are provided through activities under Coal R&D.

The major share of FY 2000 funding in Coal R&D, \$84.7 million, is focused on advanced power generation systems, which includes advanced pulverized coal-fired systems, indirect-fired cycles, IGCC, pressurized fluidized-bed (PFB) combustion and advanced research and environmental technology. The target for coal-fueled systems is to achieve efficiencies in the 42-45 percent range in the 2000-2005 period that will provide the engineering foundation for system efficiencies in the 55-60 percent range. These improvements could reduce CO₂ emissions by over 40 percent compared to current coal-fired systems.

In the advanced pulverized coal-fired program, the Low Emissions Boiler System (LEBS) will enter Phase IV, the last project phase, where the focus is to provide data needed to make LEBS commercially available. The High Performance Power System (HIPPS) in the indirect-fired cycle program will continue, at a reduced level, the engineering development phase. The focus for IGCC development will be cost improvement and performance optimization for power generation; gas stream purification; and control of hazardous air pollutants. Long term testing will continue on the transport reactor train and hot gas particulate controls for IGCC at the Wilsonville Power Systems Development Facility (PSDF). Operation of a product development unit for desulfurization will continue along with R&D and testing of other novel and advanced sulfur sorbents and systems for IGCC. Also at the Wilsonville facility, operation of an

advanced PFB pilot scale project will continue and testing of a PFB pilot scale second generation system will be initiated. Systems and materials testing and evaluation for performance improvement and cost reductions for PFB will also continue.

FY 2000 Coal environmental technology R&D activities include a rapid scaleup of efforts to introduce lower cost technologies which are effective in controlling NO_x, SO₂, and mercury, and which are appropriate for retrofit into existing powerplants. In the case of NO_x and SO₂, the primary objective of the R&D will be cost reduction. For mercury, no practical control technology now exists to significantly mitigate emissions from powerplants, so the focus is on both effectiveness and cost. In addition, there may be opportunities for innovative approaches which address two or more of these pollutants simultaneously. Finally, it should be noted that there are significant overseas markets for lower cost technologies to address NO_x and SO₂, particularly in Asia.

Advanced research on sequestration is an emerging area of interest because the potential for greenhouse gas reduction, particularly carbon dioxide, is so large, and because it is the most promising approach that is compatible with the existing energy infrastructure. Sequestration research includes a broad range of physical, chemical and biological options, which will be done in collaboration with other parts of the Department, national laboratories, other countries, and industrial firms. A balanced set of approaches will be pursued to establish both the environmental acceptability and the required technical and economic performance. Promising options identified under the 1998 "Novel and Advanced Concepts" awards will be carried to "proof-of-concept", and funding leveraged where appropriate through international collaboration. The long-term program goal is to achieve large-scale carbon sequestration at \$10/ton. FY 2000 funding for Fuels Research is \$14.5 million, and focuses on technologies for producing clean, economically competitive coal-derived liquids. The aim is to develop environmentally superior processes for transportation and boiler (utility, industrial and commercial application) fuels and chemical feedstocks which can compete with petroleum crude at \$20 per barrel by the year 2020. Activities with intermediate term impacts are being carried out cooperatively with the Office of transportation Technologies (EE) and the Office of Oil and Gas, Emerging Processing Technology. The objective is to develop premium fuels that can be used with new diesel engines in light trucks and sports/utility vehicles to achieve much greater system efficiency with significantly reduced emissions. Activities with longer-term payoffs will be carried out under the Advanced Research activity and emphasize conversion of coal directly, or in combination with other domestic feedstocks and waste materials, to competitively-priced transportation liquids that are environmentally (including greenhouse gases) acceptable. Advanced processes will be incorporated to facilitate liquefaction processes, such as dense-ceramic membranes, which are being developed in the oil and gas R&D program.

FY 2000 funding for Advanced Research and Technology Development is \$23.1 million, and focuses on two types of activities. The first is a set of crosscutting fundamental research programs which includes coal utilization science, materials and components,

bioprocessing of coal, and university-based coal research. These programs focus on developing the enabling science critical to advanced technologies, and reflect increasing emphasis on activities such as “virtual demonstration plants” that will use supercomputing approaches to minimize the need for costly demonstration projects . The second set of programs include crosscutting studies and assessment activities in environmental, technical and economic analyses, coal technology export, and international program support. These studies support strategic planning and enhance all Fossil Energy endeavors.

Fuels and power-related program goals are integrated under a concept called “Vision 21,” which seeks to realize the full potential of our abundant fossil fuel resources while addressing climate change concerns. Vision 21 was endorsed in the November 1997 report by the President’s Committee of Advisors on Science and Technology (PCAST), and supported by the National Research Council and other stakeholder groups. Vision 21 plants comprise a portfolio of fuel-flexible systems and modules capable of producing a varied slate of high-value fossil fuels, (or in combination with other opportunity fuels or feed-stocks) commodities and/or electricity tailored to market demands in the 2010-2015 time frame. Distinguishing features of the Vision 21 fleet are (1) capability to produce cheaper electricity at efficiencies over 60 percent; (2) near zero pollutants to meet more stringent emissions standards (less than one-tenth of New Source Performance Standards for criteria pollutants) at a lower cost; (3) options for no net CO₂ emissions; (4) fuel flexible (coal plus other opportunity fuels); and (5) a flexible set of integrated modules configured to meet a range of market applications and capable of producing an array of high-value commodities (such as chemicals, high-quality steam, liquid fuels, and hydrogen) at competitive prices in a free market.

The Administration’s Climate Change Technology Initiative crosscuts a number of FE program elements. A total of \$37 million in the FE budget for FY 2000 is associated with R&D related to climate change. The most significant portions of this funding relate to designing power systems to be more efficient, which means they emit less carbon dioxide; modifying advanced power systems to accommodate carbon sequestration; and development of carbon sequestration itself.

Significant potential benefits can be realized from achieving the Coal and Power Systems goals. Reductions in the cost of electricity can amount to \$5 to \$15 billion in savings per year to consumers. The global sales of U.S. industry's advanced power systems can reap revenues of \$200 billion based on only 20% of the projected \$1 trillion world power equipment market, and could support more than 3 million job-years over three decades. Achieving the environmental goal will lower NO_x and hazardous air pollutants by 70 to 90 percent while reducing existing and future environmental compliance costs, thereby producing savings of over \$7 billion per year to the U.S. industry.

Natural Gas Research

In FY 2000, \$105.3 million is requested for natural gas activities, of which \$79.4 is for gas power applications to continue the strong emphasis on development of advanced, super-clean, high efficiency turbine and fuel cell power generation systems utilizing this clean fossil fuel. In addition to gas applications, these systems will also be important components of next generation, high efficiency coal powerplants.

Under the Advanced Gas Turbine Systems (ATS) Program, DOE is requesting \$41.8 million in FY 2000 to continue support of two manufacturers seeking to develop a turbine that will surpass any other utility-scale turbine offered in the world. More than 70 percent of all new power generation equipment installed in the U.S. after the year 2000 is forecast to be derived from the DOE ATS program. In the combined cycle mode, the turbine will achieve 60 percent efficiency, single digit nitrogen oxide levels, and a 10 percent reduction in electricity costs compared to current systems. In FY 2000, validation testing for critical components will be completed, and full speed, no load testing will be initiated for one manufacturer, which is the last step before demonstration. The utility-scale turbine is expected to be commercialized in 2002.

The impending deregulation and restructuring of the utility industry is accelerating the adoption of distributed power generation, which potentially offers opportunities for cost-effectively meeting peak demand without the need for capital intensive central station capacity or costly investments in transmission and distribution. Distributed generation could provide clean power to remote end users and new business opportunities for both utility and non-utility owners. The fuel cells program, for which \$37.6 million is requested in FY 2000, is developing advanced power systems for distributed generation that will improve power quality, boost system reliability, reduce energy costs and environmental emissions, and help delay/defray capital investments. Two molten carbonate and one tubular solid oxide fuel cell systems are currently being pursued, where the main focus in FY 2000 is on stack improvements and cost reduction through improved components. In FY 2000 testing will be completed on the first pressurized 250 kilowatt solid oxide/micro gas turbine, combined cycle system at the National Fuel Cell Research Center.

FY 2000 funding requested for natural gas supply-related activities is \$25.9 million, which contributes to the technology base needed to ensure that future domestic gas supplies are adequate and reasonably priced. EIA, in its 1998 Annual Energy Outlook (AEO98), projects a 46 percent increase in domestic natural gas consumption by 2020, with two-thirds used for electric power generation. This requires increasing gas production from parts of the vast domestic resource base that are not currently economical to recover because of the geological setting, quality of the gas, or location relative to infrastructure. The gas program focuses on technical and market

needs, and is closely coordinated with efforts by the Gas Research Institute (the research arm of the natural gas industry), other industry energy research, and related research in DOE's Office of Energy Efficiency and Renewable Energy, and Office of Energy Research.

Natural Gas Supply and Processing activities are focused on helping to ensure the long-term availability and reliability of natural gas at reasonable prices and to improve the Nation's ability to store, transport, and distribute gas in an economic, efficient, and environmentally beneficial manner. Supply R&D is carried out under the areas of Exploration and Production, Delivery and Storage, Effective Environmental Protection, and Emerging Processing Technologies.

Exploration and Production program activities include advanced drilling, completion, and stimulation; advanced diagnostics and imaging systems, the multi-National Laboratory/Industry partnership, resources and reserves, and methane hydrates systems.

- Projects in the advanced drilling, completion, and stimulation area are developing and demonstrating tools and techniques that will access complex geological settings with minimum formation damage, reduce costs and improve recovery, and minimize the need for drilling-related waste disposal. Drilling, completion, and stimulation technologies include technologies for high temperature and pressure; steerable air percussion measurement-while-drilling systems; coiled-tubing and steerable air percussion drilling systems; and new rock cutting systems. These technologies are expected to result in incremental increases in annual gas production of 1 Tcf and reserve additions of 13 Tcf of gas by 2010.
- The advanced diagnostics and imaging systems program is developing technologies to improve seismic and other geophysical acquisition systems, processing, and interpretation. These technologies will reduce the number of dry holes; improve production from fractured reservoirs; and increase the cost effectiveness of field development, infill drilling, and extraction processes.
- The resource and reserves program will increase U.S. exploration through greater industry access to and use of geologic and geophysical basin-scale data; and transfer of technology to industry. The secondary gas recovery project, utilizing 3-D seismic imaging, vertical seismic profiling, advanced computational synthesis and advanced drilling technologies, has changed conventional wisdom about natural gas reservoirs. In South Texas, where projects have been concentrated, success rates in locating and producing gas are averaging 78 percent, among the highest in the Gulf Coast region. By 2000, more than 2.6 Tcf of additional gas will be produced that otherwise might have been left in the ground. The secondary gas recovery, now in its third phase, is being expanded into the Appalachian region. The a new stripper well revitalization project will be initiated in 3 states.

- An R&D program in methane hydrates is being developed with the goal of converting the potential gas hydrates resource (estimated at up to 200,000 Tcf) into gas reserves while developing technologies to assure safe petroleum operations in hydrate areas, and defining the role of methane hydrates in global climate.

Delivery and storage efforts are focused on developing cost-effective technologies to prevent or moderate storage field deliverability decline; expand peaking storage capacity; and develop real-time measurement technologies.

Emerging Processing Technologies focus on developing of more efficient processes to upgrade the estimated 300 Tcf of domestic natural gas resources that are low-quality and do not meet pipeline standards; and developing promising technologies for gas-to-liquids conversion. In FY 2000 efforts will continue on an industry co-funded ceramic membrane technology project which, if successful, will be the breakthrough to converting gas to liquid fuel at competitive economics with oil-based fuels. Successful gas-to-liquids conversion would extend the life of the Trans-Alaska oil pipeline and lead to additional North Slope oil production. This technology will also allow remote and deep-water gas to be converted to transportable liquid fuels and petrochemicals, and provide a source of ultra-clean diesel fuels that have environmental and efficiency benefits over petroleum-derived diesel.

The Effective Environmental Protection program is addressing detection and control of air emissions from gas equipment and facilities, treatment of produced water to meet environmental standards, remediation of soils that have been contaminated with hydrocarbons or produced water, treatment and disposal of wastes containing naturally occurring radioactive materials, and other approaches to manage gas field wastes. The program works to lower the cost of effective environmental protection in these environmental issue areas through a combination of risk assessment technology development, regulatory streamlining, impact analysis, and facilitating dialogue that attempts to achieve consensus among affected parties on ways to balance the need to develop the Nation's energy resources with the maintenance of our environmental values.

Oil Technology

In FY 2000, \$50.2 million is requested for petroleum activities. Oil R&D activities seek to enhance energy security through increased domestic production, and help the U.S. to be a responsible steward of its oil resources. Marginally economic wells with high remaining resource potential, but low profitability, are being abandoned at an alarming rate. The cumulative impact is that tens of billions of barrels of oil may never be economically producible. Oil technology R&D will help preserve the availability of these resources, extend reservoir life, and increase domestic production by over 500,000 barrels/day by 2010, offsetting equivalent amounts of imports.

Objectives of the oil technology program include: stop the decline in domestic oil production; improve the capability of the Nation's petroleum industry to increase the supply of secure, domestic oil; and reduce and resolve environmental issues associated with domestic oil production and processing. These activities are carried out under the areas of exploration and production, reservoir life extension and management, and effective environmental management.

Exploration and production research consists of exploration and advanced drilling, completion, and stimulation systems, advanced diagnostics and imaging systems, the Multi National Lab/Industry Partnership, reservoir efficiency processes, and planning and analysis efforts.

- Exploration work aims to stimulate activity in currently underdrilled areas and in untested formations within older producing areas
- Advanced drilling, completion, and stimulation work focuses on developing tools and techniques to drill, complete and stimulate oil wells that can achieve and maintain higher production rates.
- Advanced diagnostics and imaging systems work focuses on the development of technologies and methodologies that improve the success rates and cost efficiencies for the development of existing fields and the discovery of new fields.
- Multi Lab/Industry Partnership activities represent an industry driven program utilizing a wide range of tools developed for the defense programs and adapted to oil and gas use to improve seismic, production, drilling, and environmental technology.
- Reservoir efficiency processes include research to develop and demonstrate tools and methodologies that permit oil operators to recover hydrocarbons in mature reservoirs that are not producible by current technology.

Reservoir life extension and management work focuses on coordinating oil technology activities in research, development, and demonstration of advanced technologies to improve recovery of hydrocarbons from mature oil reservoirs. Activities in this area include revisiting major reservoir groups to address key production problems, and increasing production from marginal wells. In FY 2000, activities will be initiated in the reservoir life extension and management area for a preferred "Petroleum Upstream Management Practices (PUMP) Program. PUMP is designed to provide a short-term supplement to mid- and long-term R&D and will focus on data management and effective environmental compliance. PUMP will use known technology transfer mechanisms, regional approaches, and integrated solutions to technology, regulatory, and data constraints.

Effective environmental protection research activities are conducted under both the gas and oil programs and focus on technologies and practices that reduce the threat to the environment and decrease the cost of effective environmental protection and compliance involved in gas and oil exploration, production, and oil processing. In FY 2000, the program will focus on detection and control of air emissions from gas and oil equipment and facilities, treatment of produced water to meet environmental standards, remediation of soils that have been contaminated with hydrocarbons or produced water, treatment and disposal of wastes containing naturally occurring radioactive materials, underground injection of produced water, and other approaches to manage oil and gas field wastes. Activities also include identification of pollutants present in petroleum and development of technologies to prevent their formation and to reduce emissions from petroleum fuels. Also, the program will implement, together with states and industry, on-line expert systems for environmental permitting and reporting that can save both producers and state regulators time and money. Through these activities with state governments and industry, the gas and oil environmental program can contribute toward decreasing cumulative industry compliance costs, between now and 2010, by as much as \$16 billion, increase gas production by 90 billion cubic feet per year, and retain production of up to 140,000 barrels per day of oil that would otherwise be abandoned.

External Inputs to FE Program Planning

A number of expert groups representing industry and academia have provided guidance on FE program priorities. For example:

- The President's Committee of Advisors on Science and Technology (PCAST), in its November 1997 report "Federal Energy Research and Development for the Challenges of the Twenty-First Century," recommended strong support for: 1) Vision 21, zero-emission energy plants capable of producing combinations of energy, heat, fuels and chemicals from carbonaceous fuels; 2) new approaches for capturing and sequestering carbon; 3) methane hydrate R&D; 4) technology transfer and cost-effective demonstrations to help maintain production from mature and marginal regions of domestic oil production; and 5) foundation building R&D in universities and National Laboratories to help maintain the energy technology leadership of the United States.
- Industry groups, particularly formal advisory groups such as the National Coal Council and National Petroleum Council, provide periodic guidance. Of particular importance to oil and gas R&D activities was survey results from the National Petroleum Council study "Research, Development, and Demonstration Needs of the Oil and Gas Industry," and the Petroleum Technology Transfer Council Needs Assessment. These surveys identified potential high benefit R&D areas, considering the near- and long-term needs of both the supply and utilization sectors, where industry respondents, for a variety of reasons, do not believe the oil and gas industries will make adequate progress on their own.

- The National Research Council in 1995 provided a strategic assessment of the U.S. Department of Energy's coal programs.
- Public input is obtained through workshops on various topics held throughout the year

Other Program and Crosscutting Areas

FE is taking steps to ensure that the U.S. benefits directly from cooperative research with foreign governments and multilateral institutions as well as enhanced international regulatory coordination. FE is also working with other Departmental groups, Federal agencies, international organizations and private sector companies to promote the export of domestic fossil fuel technology, including highly efficient processes that can reduce global greenhouse gas emissions.

In the area of environment, safety and health (ES&H), FE is working to provide a safe environment at the FE R&D facilities, as well as at off-site locations where R&D projects were sponsored. In addition, FE is responsible for correcting ES&H problems at the Albany Center, a former U.S. Bureau of Mines facility that was transferred to FE in 1997. FY 2000 funding at a level of \$10.0 million is targeted at corrective actions to ensure that the FE R&D facilities are operating in compliance with Federal, state and local ES&H requirements, and that the environmental contamination associated with the on-site operations and off-site locations is remediated. The major share of funding will focus on environmental remediation, indoor air quality and ventilation, industrial safety, emergency preparedness, fire protection, control of toxic and hazardous materials, and protection of water and air quality. A sustained commitment to ES&H is an important factor in retaining public trust in the conduct of FE activities.

The FY 2000 request for Program Direction and Management Support is \$72.1 million. The FY 2000 request recognizes the important role of the Federal Energy Technology Center in the FE program and the need to fund the sites at a level consistent with program goals. FE also promotes the development of interfuel competition and markets for U.S. natural gas and electricity through regulation of natural gas imports and exports and electricity exports by the Fuels Program.

Consistent with the R&D goals of the Department, the materials program at Albany, which was formerly associated with the U.S. Bureau of Mines, is being directed at research which will conserve materials produced from minerals. The FY 2000 request for this program is \$5.0 million. The program will be coordinated with not only Fossil Energy materials R&D but also the materials research at DOE's Office of Energy Efficiency and Renewables and Office of Energy Research. With this coordination, the Department will avoid a duplication of effort and also take full advantage of the unique expertise at the Albany Center which has focused on the full life cycle of materials. The program at Albany will stress full participation with industry and emphasize cost sharing to the extent possible.

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PROGRAM FUNDING PROFILE

<u>Sub-program</u>	FY 1998	FY 1999	FY 2000	FY 2000	Program Change	
	<u>Enacted</u>	<u>Enacted</u>	<u>Base</u>	<u>Request</u>	<u>Request vs. Base</u>	<u>Base</u>
					<u>Dollar</u>	<u>Percent</u>
Coal						
Advanced Clean Fuels Research						
Operating Expenses	\$15,559	\$15,528	\$15,528	\$14,500	\$-1,028	-7%
Advanced Clean/Efficient Power Systems						
Operating Expenses	\$72,420	\$87,676	\$87,676	\$84,737	\$-2,939	-3%
Advanced Research and Technology Development						
Operating Expenses	<u>\$17,312</u>	<u>\$19,939</u>	<u>\$19,939</u>	<u>\$23,195</u>	<u>\$3,256</u>	<u>16%</u>
Subtotal Coal	\$105,291	\$123,143	\$123,143	\$122,432	\$-711	-1%
Gas						
Natural Gas Technologies						
Operating Expenses	\$69,305	\$71,007	\$71,007	\$67,665	\$-3,342	-5%
Fuel Cells						
Operating Expenses	<u>\$39,156</u>	<u>\$44,200</u>	<u>\$44,200</u>	<u>\$37,649</u>	<u>\$-6,551</u>	<u>-15%</u>
Subtotal Gas	\$108,461	\$115,207	\$115,207	\$105,314	\$-9,893	-9%

PROGRAM FUNDING PROFILE - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

<u>Sub-program</u>	FY 1998	FY 1999	FY 2000	FY 2000	Program Change	
	<u>Enacted</u>	<u>Enacted</u>	<u>Base</u>	<u>Request</u>	<u>Request vs. Base</u>	<u>Dollar</u> <u>Percent</u>
Petroleum						
Oil Technology						
Operating Expenses	<u>\$47,708</u>	<u>\$48,616</u>	<u>\$48,616</u>	<u>\$50,166</u>	<u>\$1,550</u>	<u>3%</u>
Subtotal Petroleum	\$47,708	\$48,616	\$48,616	\$50,166	\$1,550	3%
Program Direction and Management Support						
Operating Expenses	\$66,830	\$69,481	\$69,481	\$72,079	\$2,598	4%
Plant and Capital Equipment						
Construction	\$2,532	\$2,600	\$2,600	\$2,000	\$-600	-23%
Fossil Energy Environmental Restoration						
Operating Expenses	\$12,935	\$11,000	\$11,000	\$10,000	\$-1,000	-9%
Cooperative Research and Development						
Operating Expenses	\$5,686	\$6,836	\$6,836	\$5,836	\$-1,000	-15%
Fuels Program						
Operating Expenses	\$2,173	\$2,173	\$2,173	\$2,173	\$0	0%
Advanced Metallurgical Processes						
Operating Expenses	\$4,965	\$5,000	\$5,000	\$5,000	\$0	0%
Use of Prior Year Balances						
Operating Expenses	<u>\$-64</u>	<u>\$0</u>	<u>\$0</u>	<u>\$-11,000</u>	<u>\$-11,000</u>	<u>0%</u>
Total	<u>\$356,517</u>	<u>\$384,056</u>	<u>\$384,056</u>	<u>\$364,000</u>	<u>\$-20,056</u>	<u>-5%</u>

PROGRAM FUNDING PROFILE - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

<u>Sub-program</u>	<u>FY 1998</u> <u>Enacted</u>	<u>FY 1999</u> <u>Enacted</u>	<u>FY 2000</u> <u>Base</u>	<u>FY 2000</u> <u>Request</u>	<u>Program Change</u> <u>Request vs. Base</u>	
					<u>Dollar</u>	<u>Percent</u>
Summary						
Operating Expenses	\$353,985	\$381,456	\$381,456	\$362,000	\$-19,456	-5%
Construction	<u>\$2,532</u>	<u>\$2,600</u>	<u>\$2,600</u>	<u>\$2,000</u>	<u>\$-600</u>	<u>-23%</u>
Total Program	<u>\$356,517</u>	<u>\$384,056</u>	<u>\$384,056</u>	<u>\$364,000</u>	<u>\$-20,056</u>	<u>-5%</u>
Staffing (FTEs)						
Headquarters	116	116	116	116		
Field	<u>544</u>	<u>563</u>	<u>563</u>	<u>565</u>		
Total Staffing	<u>660</u>	<u>679</u>	<u>679</u>	<u>681</u>		

Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)

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SUMMARY OF CHANGES

	FY 2000 <u>Request</u>
FY 1999 Enacted	\$384,056
- Non-Discretionary	<u>0</u>
FY 2000 Base	\$384,056

Advanced Clean Fuels Research

- Coal Preparation - The decrease provides for continuing research on methods for coal cleaning to produce premium fuels, reduction of air toxic precursors, and high efficiency processes development	-1,097
- Direct Liquefaction - The decrease provides for continuing exploratory and bench scale research in two-stage liquefaction to achieve greater efficiency and lower costs	-1,509
- Indirect Liquefaction - The increase provides for continuing bench scale research on advanced liquefaction and waste/coliquefaction studies; oxygenate catalyst and reactor studies; and syngas polishing and integrated studies .	1,159
- Advanced Research and Environmental Technology - The increase continues research on coprocessing of coal with waste material, improved methods for characterizing coal-derived liquids and advanced catalytic approaches to coal liquefaction, developing concepts for producing and studying carbon materials, laboratory scale research on producing liquid transportation fuels and chemicals	419

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

Advanced Clean/Efficient Power Systems

- Advanced Pulverized Coal-Fired Powerplant - The decrease completes funding for Phase IV which will conclude with the construction and operation of proof-of-concept (POC) facility -12,000
- Indirect Fired Cycle - The increase provides for continuation of Phase II engineering development of concepts to serve as a combustion technology for Vision 21 510
- High Efficiency-Integrated Gasification Combined Cycle - The increase will continue cost improvement techniques and performance optimization of IGCC for power generation; gas stream purification and the control of hazardous air pollutants, and the development and demonstration of technologies for reducing greenhouse gas emissions. The increase also adds development of advanced fuel cells systems for Vision 21 gasification/combustion applications in conjunction with gas-based fuel cells systems development 6,273
- High Efficiency--Pressurized Fluidized Bed - The decrease will continue research to fully integrate operation of the Advanced Pressurized Fluidized Bed pilot scale project at the Wilsonville Power System Development Facility and continue engineering of design concepts to serve as a combustion technology for Vision 21 -2,436
- Advanced Research and Environmental Technology - The increase will provide additional PM_{2.5} monitoring stations in other regions to better understand the contributions of emissions from coal-fired power plants to ambient PM_{2.5} levels and to develop adequate PM_{2.5} precursors emission control technology to meet new regulations in a cost-effective manner; and exploratory research on novel and advanced concepts for greenhouse gas capture, separation, storage and reuse 4,714

Advanced Research and Technology Development

- Coal Utilization Science -The increase provides for continued research toward the Grand Challenges of the Virtual Demonstration Plant and CO₂ capture, and sequestration, in support of the Vision 21 power and fuels complex 1,920
- Coal Technology Export - The funding provides for continued support for coal and technology export programs and promotion initiatives; assists in trade missions and other activities to promote the export of clean coal technologies; and continues the coordination of all FE international related crosscutting activities 0

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Bioprocessing of Coal - The increase provides for the development of biological processes to sequester CO ₂ by natural mitigation strategies and ongoing bioprocessing efforts	268
- University Coal Research - The increase continues support for university research and undergraduate internship programs	93
- Materials - The increase provides for continued program development efforts on high temperature intermetallics, ceramic composites and high temperature filters, membranes, and solid state electrolyte functional materials.	775
- Environmental Activities - The decrease continues environmental analyses of air and water quality, solid waste disposal, toxic substance releases, and global climate change	-200
- Technical and Economic Analysis - The increase continues studies supporting multi-year planning, FE strategy, and program formulation, provides analytical support for fossil related Energy Policy Act implementation; supports state and regional efforts to develop energy analysis capability	50
- International Program Support - The increase continues analysis, studies and technical evaluations of ongoing and planned bilateral and multilateral activities; and continues support for international initiatives that leverage fossil energy resources	250
- HBCUs, Education and Training - The increase continues efforts to accelerate workforce diversity in fossil fuel related technologies	100

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

Natural Gas Technologies

- Exploration and Production - The increase continues a cooperative drilling program with industry; research in low-permeability reservoir field demonstrations; development of a natural gas data base and atlases; gas technology transfer efforts; initiate diagnostics to locate gas hydrate deposits in offshore environments; and conduct engineering assessments to determine candidate areas for restimulation tests 1,500
- Reservoir Life Extension/Management - The funding continues a cooperative program with industry to develop deliverability and enhancement technology, advanced storage concepts, and advanced gas measurements 0
- Turbines - The decrease continues the ultra high efficiency gas turbine technology program; full-scale testing of critical components; development of high efficiency gas turbines for electric power generation; and evaluation of humid air turbine applications -2,692
- Emerging Processing Technology Applications - The decrease continues assessments of gas conversion feasibility; support for an international center or information on natural gas technologies; and research in low-quality gas upgrading -1,750
- Effective Environmental Protection - The decrease continues environmental research including data analysis, risk assessment, application of advanced research, and technology development. Continues outreach and technology transfer program on environmental issues related to natural gas. Continues pilot test of NORM treatment and disposal alternatives -400

Fuel Cells

- Advanced Research - The funding continues research on molten carbonate and solid oxide systems to lower costs, investigate advanced processes and designs, and to solve fundamental crosscutting materials and design issues 0
- Fuel Cell System Development/Vision 21 - The decrease continues system/stack improvement efforts; continues supporting assessments and studies; and continues industry cost-shared cost reduction and product improvement research in conjunction with fuel cells systems development for gasification/combustion applications in support of Vision 21 -4,551

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Multi-Layer Ceramic Technology for Fuel Cells - No funding is requested for this activity -2,000

Oil Technology

- Exploration and Production Supporting Research - The increase continues efforts in advanced drilling, completion, and stimulation (ADCS), advanced diagnostics and imaging systems (ADIS), national lab/industry partnership, reservoir efficiency processes, technology transfer and analysis and planning 750
- Recovery Field Demonstrations - The funding continues efforts in recovery field demonstration projects including revisit of classes 1-3 and increased production from marginal wells, and adds the preferred upstream management practices (PUMP) 0
- Effective Environmental Protection - The increase continues efforts in program planning and analysis, environmental regulatory review, risk assessment, and technology development 800

Program Direction and Management Support

- Headquarters Salaries and Benefits - The increase provides for 97 FTEs at Headquarters. This staff implements and communicates policy to the FETC, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans, and monitors work progress 380
- Headquarters Travel - The increase provides funds for travel in support of the activities stated above. Both domestic and international travel are conducted 69
- Headquarters Contract Services - The increase provides for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services, E-mail and LAN requirements, computer timesharing/housekeeping, and the working capital fund which provides overhead expenses 518

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Field Salaries and Benefits - The increase provides funds for 315 FTEs at the Federal Energy Technology Center (FETC) and the National Petroleum Technology Office (NPTO). Activities of the staff include contract and lab monitoring, development and maintenance of project, budget and procurement plans, and other activities related to program and site support 1,322
- Field Travel - The increase provides funds for travel in support of the above stated activities in the attainment of program goals, both on the domestic front and abroad 54
- Field Contract Services - The increase provides funds for facility operations, maintenance, finance automated office support service, administrative, management and technical support 255

Plant and Capital Equipment

- Construction - The decrease provides funding for general plant projects at the Federal Energy Technology Center and the National Petroleum Technology Office -600

Cooperative Research and Development

- Cooperative Research and Development - The decrease provides for continued research and UNDEERC and WRI -1,000

Fossil Energy Environmental Restoration

- CERCLA Remedial Actions - The decrease provides funding for the continued cleanup of the Rock Springs and Hoe Creek sites; continuation of the Hannah site revegetation; soil and groundwater cleanup at the FETC-PGH former liquefaction site; and assessment/site investigations of inactive projects -1,403
- RCRA Remedial Actions - The decrease provides for continued on-site remediation activities -78
- Other ES&H Actions - The increase provides for continuing recurring ES&H activities at the FETC sites 481

Fuels Program

- Fuels Program - The funding level remains at the FY 1999 level of funding and provides for 19 FTEs 0

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

Advanced Metallurgical Processes

- Advanced Metallurgical Processes - The funding continues research on extending the service life on materials while addressing ways to improve environmental impact of hazardous materials paths and processes; and provides for 85 FTEs	0
<u>Use of Prior Year Balances</u>	<u>-11,000</u>
FY 2000 Congressional Budget Request	\$364,000

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

ADVANCED CLEAN FUELS RESEARCH

I. Mission Supporting Goals and Objectives:

The Energy Policy Act (EPACT) of 1992 Title XIII, Subtitle A, Section 1301 authorizes programs research, development, demonstration and commercialization of coal based technologies. Title XIII, Subtitle A, Sections 1305 and 1312 of this act also authorizes separate programs for research, development, demonstration and commercial application of improved technologies to refine coal to a variety of fuel and non-fuel products and to convert coal into oil substitutes. In compliance with these provisions of EPACT and consistent with these goals, the Advanced Fuels Research Program consists of five related activities: Coal Preparation, Direct Liquefaction, Indirect Liquefaction, Advanced Research and Environmental Technology, and Systems for Coproducts.

Coal Preparation (Solid Fuels and Feedstock) - The program's funding is directed toward the development of advanced solid fuels and feedstocks technologies to: (1) develop and verify innovative processing, handling, and transportation technologies that will improve the overall efficiency, economics, and environmental performance of energy utilization systems, (2) reduce environmental impacts associated with the generation of greenhouse gases and hazardous air pollutants from utilization of coal, (3) permit greater recoveries of the useful energy of the mined coal, (4) encourage the recovery of previously lost carbon raw materials from waste (culm piles/ponds), and (5) support the development of technology for the production of premium carbon and industrial products. These technologies will yield a wide range of products that are economically competitive and which meet the specifications for and can be used with less environmental impact than other competing fuels and products.

Coal Liquefaction (Coal Derived Transportation Fuels) - The need for liquid fuels is forecast to be a critical element of this nation's energy future in the 21st century. The Coal Liquefaction program supports basic and applied research to develop the scientific and engineering knowledge base with which industry can bring economically competitive and environmentally acceptable advanced technology for the manufacture of liquid fuels from coal into the marketplace when needed. Coal Liquefaction produces a complete spectrum of liquid fuels which could be utilized in the existing infrastructure.

I. **Mission Supporting Goals and Objectives:** ADVANCED CLEAN FUELS RESEARCH (Cont'd)

The Department's efforts are focused upon the two different and distinct approaches to producing liquid fuels from coal, direct liquefaction and indirect liquefaction. Direct liquefaction processes convert the complex organic chemical structures found in coal directly to liquid components by hydrogenation. Indirect liquefaction involves coal gasification to produce synthesis gas (a mixture of carbon monoxide and hydrogen) followed by the catalytic conversion of the synthesis gas to liquids. Each of these approaches has unique characteristics that make it a candidate for commercial development under certain market conditions. The Coal Liquefaction program is being structured to include entrance technology which would be integrated with existing facilities; thereby decreasing the cost of coal-derived liquid products. This program being coordinated with the Office of Transportation Technologies (EE) and the Office of Oil and Gas, for the development of premium fuels and new diesel engine development for use in sports/utility vehicles and light trucks which will achieve significantly greater efficiency with substantially lower emissions. The FY 2000 budget request supports the continued development of coal derived transportation fuels technologies at the laboratory and bench scale and support studies and engineering evaluations are needed to guide the research and development efforts in support of the objective of providing coal-derived liquid fuels at costs competitive with crude oil around \$19-25 per barrel within the next decade.

Advanced Research and Environmental Technology (Advanced Fuels Research) - The thrust of this subprogram includes elements that respond to the "Grand Challenges" which coal fuel technologies must overcome to continue coal use in sustainable manner during the next century. These elements include research and early development of improved and innovative concepts for producing transportation fuels, chemicals and carbon products with high efficiency, improved environmental performance, and reduced carbon dioxide production.

Performance Measures:

The Advanced Clean Fuels Research Program is developing a suite of technologies aimed at utilizing domestic natural gas, coal, and waste resource in an environmentally friendly manner to produce ultra-clean transportation fuels, chemicals, solid feedstocks and carbon-based premium products. Achievement of this goal would provide a significant reduction in regional pollutants such as SO₂, NO_x, and particulates from both stationary (power plant, industrial boiler) and mobile sources. The U.S. transportation sector currently accounts for approximately 80% of carbon monoxide, 50% of nitrogen oxides, 40% volatile organic compounds emissions into our urban air. Advanced Fischer-Tropsch (F-T) and oxygenate technologies under development will produce fuels which can reduce hydrocarbons by 46%, CO by 47%, NO by 9% and particulates by 32% relative to current emissions derived from conventional petroleum diesel. Use of these ultra-low emissions Fischer-Tropsch and oxygenated fuels in new, highly efficient engines, being

I. **Mission Supporting Goals and Objectives:** ADVANCED CLEAN FUELS RESEARCH (Cont'd)

developed in the Department's Office of Transportation Technology Programs, could achieve double the mileage efficiency when compared to today's automobiles and light trucks.

In addition, there are configurations using advanced coal gasification and F-T technologies that can coproduce transportation fuels and electric power from coal and natural gas and significantly reduce carbon emissions compared to current technology. For example, if all current pulverized coal plants were replaced by such coproduction facilities, then 2.9 million barrels per day of fuels could be produced in addition to all the power with an overall savings of 150 million tons per annum of carbon.

If domestic production of liquid fuels could be increased by 1 million barrels per day using domestic natural gas and coal fuels, our Nation's balance of payments deficit could be reduced by \$130 billion between 2015 and 2030 and domestic jobs (direct and indirect) could be increased by 250,000.

The introduction of technologies for solid fuels and feedstocks will be important for precombustion environmental control for power production, cleanup and utilization of waste U.S. coal piles and ponds, and the tailoring of carbon feedstocks from coal for high-value premium carbon products, improved transportation fuels, and chemicals. The introduction of technologies which permit the utilization of advanced "coal-biomass" fuels offer the potential for up to 50% reductions in carbon dioxide emissions from U.S. power plants. Precombustion control of hazardous air pollutant precursors can permit at least a 20% reduction in mercury emissions, and advances in solid fuel preparation technologies can facilitate a 50% reduction in nitrogen oxides from existing and future U.S. power plants. The introduction of fine coal and dewatering technology can permit the economic utilization of the estimated 3 billion tons of discard coal presently existing in the U.S. and eliminate associated environmental problems.

Activities in FY 2000 in support of this goal include the following:

- Continue feasibility studies for Early Entrance Coproduction Plants.
- Complete slurry reactor hydrodynamic testing for reactor modeling.
- Evaluate the Phase I lab-scale project activities performed under the Solid Fuels & Feedstocks Grand Challenges PRDA.

II. A. **Funding Schedule**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Coal Preparation	\$4,993	\$5,097	\$4,000	\$-1,097	-22%
Direct Liquefaction	5,704	3,150	1,641	-1,509	-48%
Indirect Liquefaction	4,125	5,500	6,659	1,159	21%
Advanced Research and Environmental Technology	<u>737</u>	<u>1,781</u>	<u>2,200</u>	<u>419</u>	<u>24%</u>
Total, Advanced Clean Fuels Research	<u>\$15,559</u>	<u>\$15,528</u>	<u>\$14,500</u>	<u>\$-1,028</u>	<u>-7%</u>

II. B. **Laboratory and Facility Funding Schedule**:

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Federal Energy Technology Center	\$5,017	\$3,341	\$4,390	\$1,049	31%
Sandia National Laboratories	840	560	300	-260	-46%
All Other	<u>9,702</u>	<u>11,627</u>	<u>9,810</u>	<u>-1,817</u>	<u>-16%</u>
Total, Advanced Clean Fuels Research	<u>\$15,559</u>	<u>\$15,528</u>	<u>\$14,500</u>	<u>\$-1,028</u>	<u>-7%</u>

III. **Performance Summary**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Coal Preparation	Premium Fuels/Air Toxics:	Air Toxics:	Air Toxics:
	Continue research on advanced coal cleaning to remove air toxic precursors focusing on mercury removal. (\$500) (TBD)	Initiate research for very high removal of mercury and other air toxic precursors at significantly lower cost than achievable with current technologies. (\$1,500) (TBD)	Conduct research for very high removal of air toxic precursors at significantly lower cost than achievable with current technologies. (\$80) (TBD)
	High Efficiency Processors:	High Efficiency Processors:	High Efficiency Processors:
	Continue high efficiency process development efforts at outside facilities (\$408). Conduct advanced carbon recovery research (\$197). (Total \$605) (CI, VPI, ARC, TBD)	Continue high efficiency process research to further develop the technology base for efficient beneficiation, handling and marketing of coal fines. Initiate research at outside facilities for advanced technologies for enhanced carbon recovery from coal and for the preparation of coal/biomass/waste feeds. (\$745) (TBD)	Continue high efficiency process research. Continue research at outside facilities on advanced technologies for the reduction of greenhouse gas emissions via the preparation of biomass feeds for cofiring applications and the development of composite coal/biomass/waste fuels; and remediation of coal fines disposal problems via improved fine coal recovery. (\$1,012) (TBD)

III. **Performance Summary**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Coal Preparation (Cont'd)	<p data-bbox="347 266 797 521">In-House: Conduct in-house bench-scale research on advanced physical and chemical coal cleaning and ancillary operations concepts. (\$2,573) (PETC, B&R)</p> <p data-bbox="347 704 797 1221">Initiate advanced fine coal dewatering research and development to enable the commercial deployment of advanced coal cleaning systems previously developed (\$371). Initiate activities and PRDA for advanced technologies for carbon recovery, preparation of coal/biomass/waste feeds, production of tailored feedstocks for transportation fuels and premium carbon products (\$843) (Total \$1,214) (TBD)</p>	<p data-bbox="829 266 1279 677">In-House: Conduct in-house laboratory and bench-scale research on solid fuels technologies to enhance utilization of coal waste products, improve coal fines processing, manufacture of carbon products, and prepare coal/biomass/waste feedstocks to lower emissions of greenhouse gases. (\$1,605) (FETC, B&R)</p> <p data-bbox="829 704 1279 959">Initiate research at outside facilities for advanced technologies for fine coal dewatering, and for the production of tailored feedstocks for transportation fuels and premium carbon products. (\$1,196) (TBD)</p>	<p data-bbox="1312 266 1761 677">In-House: Conduct in-house laboratory and bench-scale research on solid fuels technologies to enhance utilization of coal waste products, improve coal fines processing, manufacture of carbon products, and prepare coal/biomass/waste feedstocks to lower emissions of greenhouse gases. (\$1,735) (FETC, B&R)</p> <p data-bbox="1312 704 1761 959">Continue research at outside facilities for advanced technologies for fine coal dewatering, and for the production of tailored feedstocks for transportation fuels and premium carbon products. (\$1,133) (TBD)</p>

III. **Performance Summary**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Coal Preparation (Cont'd)	Support a Utility Sector Consortium for coal utilization research. (\$50) (UCIG)	No activity. (\$0)	No activity. (\$0)
	Fund technical and program management support. (\$51)	Fund technical and program management support. (\$51)	Fund technical and program management support. (\$40)
	\$4,993	\$5,097	\$4,000
Direct Liquefaction	Continue, at reduced level of effort, limited industrial bench scale research on advanced liquefaction processes. (\$1,366) (CAER, HTI)	Continue limited industrial bench scale research on advanced two-stage liquefaction including support of the China initiative. (\$1,490) (CAER, HTI)	Continue limited industrial bench scale research on advanced two-stage liquefaction including support of the China initiative. (\$575) (HTI)
	Continue exploratory and bench continuous studies in coprocessing research. (\$400) (HTI)	Continue exploratory and bench scale continuous studies in coprocessing research. (\$400) (HTI)	Continue exploratory and bench scale continuous studies in coprocessing research. (\$400) (HTI)
	Maintain laboratory, exploratory research on innovative process concepts. (\$1,862) (FETC, ANL, SNL, Burns & Roe, Consol)	Study of novel concepts for achieving improvements in two-stage liquefaction to achieve greater efficiency and lower cost. (\$686) (FETC, Burns & Roe, SNL)	Study of novel concepts for achieving improvements in two-stage liquefaction to achieve greater efficiency and lower cost. (\$400) (FETC)

III. **Performance Summary**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Direct Liquefaction (Cont'd)	Continue supporting engineering and economic guidance at Mitretek (\$250). Continue process stream characterization. (\$250) Initiate Pioneer plant feasibility study (\$400) (Total \$900) (Mitretek, Consol, TBD)	Continue supporting engineering economic and market studies for liquefaction technology. (\$150) (Mitretek)	Continue supporting engineering economic and market studies for liquefaction technology. (\$250) (Mitretek, Burns & Roe)
	Continue characterization and end use study for coal derived transportation fuels. (\$223) (Consol, WVU, TBD)	No activity. (\$0)	No activity. (\$0)
	Continue waste/coal coprocessing study. (\$895) (HTI)	Continue waste/coal coprocessing bench-scale studies. (\$393) (HTI)	No activity. (\$0)
	Fund technical and program management support. (\$58)	Fund technical and program management support. (\$31)	Fund technical and program management support. (\$16)
	\$5,704	\$3,150	\$1,641
Indirect Liquefaction	No activity. (\$0)	Conduct LaPorte alternative fuels facility operation for production of Fischer-Tropsch diesel and DME for engine testing in cooperation with the Office of Energy Efficiency and the Office of Oil and Gas. (\$300) (APCI)	Conduct LaPorte alternative fuels facility operation for production of Fischer-Tropsch diesel and DME for engine testing in cooperation with the Office of Energy Efficiency and the Office of Oil and Gas. (\$395) (APCI)

III. Performance Summary: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Indirect Liquefaction (Cont'd)	<p>Continue FETC in-house research on Fischer-Tropsch (F-T) chemistry (\$404). Continue bench scale F-T iron and cobalt catalyst development (\$735). Continue slurry F-T reactor design data base (\$654). (Total \$1,793) (FETC, Sandia, KY Research Foundation, Air Products, TBD)</p> <p>Continue bench scale oxygenate and chemicals catalyst and process development (\$1,680) (Air Products, RTI)</p> <p>Continue research guidance study at Mitretek (\$168). FETC technical support (\$100). Initiate feasibility study conceptual design for pioneer F-T Plant (\$150) (Total \$418) (Mitretek, Burns & Roe, ANL)</p>	<p>Continue FETC in-house research on Fischer-Tropsch (F-T) chemistry (\$750). Continue bench scale F-T iron catalyst development for coproduction of electricity, fuels and chemicals (\$900). Continue slurry reactor design data base (\$1,100). (Total \$2,750) (FETC, Sandia, Air Products, CAER)</p> <p>Continue bench scale DME diesel derivative and chemicals catalyst and process development. (\$1,100) (Air Products)</p> <p>Continue research guidance study at Mitretek (\$150). Continue feasibility study conceptual design for pioneer F-T Plant with industrial consortium (\$1,145). (Total \$1,295) (Mitretek, TBD)</p>	<p>Continue FETC in-house research on Fischer-Tropsch (F-T) chemistry (\$905). Continue bench scale F-T iron catalyst development for coproduction of electricity, fuels and chemicals (\$800). Continue slurry reactor design data base (\$950). (Total \$2,655) (FETC, Sandia, Air Products, CAER)</p> <p>Continue bench scale oxygenate research including DME diesel derivative and chemicals process development. (\$1,500) (FETC, TBD)</p> <p>Continue research guidance study at Mitretek (\$150), engineering support (\$100) and in-house engineering support studies (\$100). Continue feasibility study conceptual design for pioneer F-T Plant with industrial consortium (\$1,200). (Total \$1,550) (Mitretek, Burns & Roe, FETC, TBD)</p>

III. **Performance Summary**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Indirect Liquefaction (Cont'd)	Initiate development of the air separation membrane (\$191) (TBD)	No activity. (\$0)	Initiate advanced shift, separation research for hydrogen preparation. (\$492) (TBD)
	Fund technical and program management support. (\$43)	Fund technical and program management support. (\$55)	Fund technical and program management support. (\$67)
	\$4,125	\$5,500	\$6,659
Advanced Research and Environmental Technology	Continue research on coprocessing of coal with waste materials; continue limited research on improved methods for characterizing coal-derived liquids; continue, at a reduced level, projects on advanced catalysts for coal liquefaction, including research on fine particle size catalysts. Continue catalyst testing activities at SNL. (\$730) (FETC, SNL)	Conduct research on coprocessing of coal, resid and waste materials, biomass which could lead to clean transportation fuels with reduced CO ₂ byproduct production. Conduct research on improved and innovative methods for preparing coal-derived liquids by the Consortium for Fossil Fuel Liquefaction Science. Conduct laboratory activity to develop an extract concept for producing carbon materials such as carbon electrodes. Initiate exploratory research to improve understanding of the techniques to product carbon fiber materials. (\$950) (FETC, Univ. Of KY, WVU)	Conduct research to identify liquid fuels that are suitable as chemical storage agents for hydrogen and that may be easily reformed on board fuel cell powered vehicles. Conduct research on fuel and chemical production aspects of Vision 21 technologies, and continue exploratory research and laboratory activities for the production of high value products from coal. Conduct molecular modeling for simulating the growth of carbon structures, investigating molecular interactions, and designing catalysts. (\$1,278) (FETC, Univ. of KY, WVU, CFFLS, TBD)

III. **Performance Summary**: ADVANCED CLEAN FUELS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Advanced Research and Environmental Technology (Cont'd)	No activity. (\$0)	Initiate PRDA to conduct laboratory research on improved and innovative concepts for producing liquid transportation fuels and chemicals which will be highly efficient, achieve improved environmental performance with reduce CO ₂ byproduct production. (\$813) (TBD)	Conduct research on new and improved methods for producing liquid transportation fuels and chemicals which will be highly efficient, achieve improved environmental performance with reduce CO ₂ byproduct. (\$850) (TBD)
	No activity. (\$0)	No activity. (\$0)	Study options for incorporation of fuel and chemical modules in Vision 21 plants. (\$50) (FETC)
	Fund technical and program management support. (\$7)	Fund technical and program management support. (\$18)	Fund technical and program management support. (\$22)
	\$737	\$1,781	\$2,200
Advanced Clean Fuels Research, Total	\$15,559	\$15,528	\$14,500

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

ADVANCED CLEAN/EFFICIENT POWER SYSTEMS

I. **Mission Supporting Goals and Objectives:**

Traditionally, electric power generation generally implies large-scale production of electric power in stationary plants that are normally interconnected by a transmission and distribution system to serve the electric loads in a given area or region. This centralized mode of generation is comprised chiefly of fossil fueled power plants that have rapidly proliferated to meet growing demands but technology has improved too slowly to keep abreast of societal needs for higher efficiency and reduced environmental impacts. The impending deregulation and restructuring of the utility industry will accelerate the adoption of distributed power generation, but centralized power systems will continue to be needed as the value of electricity's capabilities continue to grow. The Advanced Clean/Efficient Power Systems (AC/EPS) program is using technical innovation to develop advanced power systems, utilizing coal--our most abundant, domestic fuel--with the capability of creating centralized power systems that can meet current requirements for higher efficiency and environmental protection and serve as building blocks to ensure sustainable development in the 21st century.

As part of the current core DOE Fossil Energy R&D Program, the AC/EPS program is addressing the development of cost-effective power systems, based on both coal and natural gas individually and in combination, that are substantially cleaner and more efficient than systems in use today. This program includes several advanced power systems based on coal combustion or coal gasification, and advanced environmental control technologies. Different kinds of power systems are being developed, each based on a different technology: advanced pulverized coal combustion; gasification combined cycle; pressurized fluidized bed combustion; indirect fired cycles; advanced turbine systems; and fuel cells in combination with turbines as a hybrid power module. Each technology development effort has its own set of objectives and time schedules for development and deployment.

To achieve radical improvements in the performance of fossil fuel-based power systems and to virtually eliminate environmental issues as a barrier to fossil fuel use will require a new paradigm for the continuing development of both technology and systems that incorporate the technology. Any of the technologies under development cannot individually achieve the efficiency, environmental, and cost goals that will be needed in the early decades of the 21st century. Rather, we need a new approach that allows us to integrate power and fuel system "modules" into systems that achieve the performance and cost goals needed to address the coming challenges.

I. Mission Supporting Goals and Objectives: ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

The new approach that we propose is called "Vision 21".

The program elements include technology developed for existing plants, advanced systems, and Vision 21.

Advanced Pulverized Coal-Fired Powerplant - These systems take pulverized coal combustion, the most widely accepted technology for coal-fired generation at the present time, a major step forward by redesigning the process to gain major performance improvements. The Low-Emission Boiler System (LEBS) integrates methods of emission control with a super critical steam cycle at the outset of design. This results in powerplants with very low emissions and significantly higher efficiency than a conventional pulverized coal power plant. Advanced Pulverized Coal-Fired systems should achieve early market entry enhancing the export potential for these technologies. Target performances are system efficiencies of 42% and SO₂ and NO_x emissions less than 1/6 the Environmental Protection Agency's New Source Performance Standards (NSPS). Three contractors completed Phases II and III of LEBS in FY 1997. DB Riley was selected to continue Phase IV, which will conclude with the construction and operation of a proof-of-concept (POC) facility in 2001. Funding for Phase IV will be completed in FY 2000.

Indirect Fired Cycle (IFC) - IFC systems are coal-fired combined cycle systems that produce energy cleanly and efficiently. The IFC program focused on High Performance Power Systems (HIPPS) incorporates a new high temperature advanced furnace which integrates combustion, heat transfer and emission control processes. The first generation HIPPS will have system efficiencies around 47% and emission levels less than 1/10 NSPS. More advanced systems will be capable of achieving system efficiencies greater than 47%, and will dramatically reduce carbon dioxide emissions levels and help mitigate global climate change. The very low pollutant emissions will enable the utility sector to better respond to projected growth in electricity demand while complying with the SO₂ emissions cap set by the Clean Air Act Amendments of 1990. In FY 2000, the major thrust will be a continuation of Phase II engineering development of concepts selected in FY 1995, and to serve as a combustion technology for Vision 21. The requested funds will be used to accelerate the development of high temperature air furnace (HITAF) technology. The HITAF is an important component supporting Vision 21. It is needed to achieve the high efficiency performance goal in Vision 21.

High Efficiency Integrated Gasification Combined Cycle - The objective of the IGCC program is to foster the development and commercialization of gasification-based processes for converting carbonaceous feedstocks to electricity and steam, fuels, chemicals, or hydrogen. Compared with today's technologies, IGCC offers the potential for significant increases in thermal efficiency as well as significant reductions in capital costs and emissions of hazardous air pollutants. In addition, IGCC is an advanced power generation technology well suited for coproducing electricity and other valuable products. In order to achieve the full potential of IGCC,

I. Mission Supporting Goals and Objectives: ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

significant advancements must be made to reduce the cost of these advanced gasification systems and to improve both the reliability and the overall system availability, while targeting efficiencies of at least 52% and reducing environmental emissions well below 1/10 NSPS. In FY 2000, the program will focus on cost improvement techniques and performance optimization of IGCC for power generation; gas stream purification and the control of hazardous air pollutants; and the development and demonstration of technologies for reducing greenhouse gas emissions. The IGCC program will be coordinated with other Departmental elements focusing on the production of fuels and chemicals from synthesis gas and the sequestration and utilization of carbon dioxide. The successful accomplishment of these activities will enhance the commercialization prospects of advanced IGCC technologies for the production of electricity by utilities, independent power producers, and other industrial stakeholders, as well as provide technologies for the coproduction of power and other valuable commodity products.

High Efficiency Pressurized Fluidized Bed (PFB) - PFB systems have several advantages including high combustion and heat transfer efficiency inherent to fluid beds; sulfur dioxide removal integral to the combustion process through introduction of sorbent into the fluid bed; and low NO_x emissions as a consequence of low combustion temperatures. Combustion efficiency, SO₂ and NO_x control are all enhanced by application of pressure. The PFB program is directed toward developing systems with efficiencies approaching 45% with SO₂ and NO_x levels of 1/5 NSPS and conducting research to further improve the efficiency of the PFB systems to over 50% with SO₂ and NO_x levels of 1/10 NSPS. The thrust of the research is in hot gas particulate filtration, critical to advanced PFBC systems, and improvements in the subsystems and the interfaces thereof to enhance system efficiency and reduce cost and pollutant emissions necessary for market entry. In FY 2000, major emphasis will be on fully integrated operation of the Advanced Pressurized Fluidized Bed pilot scale project at the Wilsonville Power System Development Facility and continue engineering of design concepts to serve as a combustion technology for Vision 21. This project also directly supports PFB technology being demonstrated at commercial scale in the Clean Coal Technology program.

Advanced Research and Environmental Technology - This subprogram involves supporting crosscutting activities that are essential to the development of advanced clean/efficient power systems and highly efficient, cost-effective environmental control technologies for retrofitting to existing powerplants, with applications to new plants as well. Results of this advanced research are used by those who develop, design, manufacture and operate both existing and advanced systems across the entire spectrum of coal utilization technologies not only to improve efficiencies, but also to improve environmental performance. Environmental Technology crosscutting efforts address the cost-effective removal of pollutant causing contaminants from fossil fueled systems. It focuses on the development of super clean emissions control technology (greater than 95% reduction) for SO₂, NO_x, air toxics and particulates to address the energy and environmental demands of the post-2000 timeframe; development of emission controls with saleable byproducts to minimize or

I. **Mission Supporting Goals and Objectives:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

eliminate liquid/solid wastes from coal-fired powerplants; sampling and characterization of advanced power system byproducts; and test and evaluation of disposal and utilization systems for coal utilization byproducts. A major thrust of this program area is the development of technology to comply with the requirements of the Clean Air Act Amendments (CAAA) of 1990 and new or pending regulations. The FY 2000 budget request emphasizes development of retrofit NO_x control technologies for compliance with CAAA Title I and Title IV, Phase II regulations and new PM_{2.5} and ozone National Ambient Air Quality Standards for essentially all existing coal-based power plants.

Currently, over half of the electricity generated in the U.S. is produced in coal-fired power plants. The U.S. power generation industry needs to maintain a diversified fuel mix to ensure adequate energy supplies at a reasonable price. The future use of coal is threatened by numerous environmental issues, especially global climate change. Ultimately, to maintain stable concentrations of greenhouse gases in the atmosphere while permitting world-wide economic growth, it will be necessary to sequester carbon from fossil fuels.

The principal thrust of the CO₂/Sequestration activity is to develop the applied science and new technologies for addressing the cost-effective management/sequestration of carbon emissions from the production and use of fossil fuels. This activity is focused on cost-effective novel concepts for capturing, reusing or storing, or otherwise mitigating carbon emissions. Included in the mix of “direct” control options is the direct capture of CO₂ at the power plant before it enters the atmosphere and storage in geologic structures such as oil and gas reservoirs, unmineable coal seams, and deep saline reservoirs. It also includes research on technologies for integrating fossil fuel production and use with “indirect” sequestration by enhancing natural sinks. Included in this area are means to achieve integration with terrestrial sequestration and enhanced ocean storage of carbon. Research activities are geared toward developing strategies that will reduce the cost of sequestration to \$10/ton of carbon. In addition to being cost-effective, these approaches must be environmentally safe and integrate with both existing and new (such as Vision 21) fossil energy conversion systems. The major thrust in FY 2000 will center around continuing exploratory research on advanced and innovative concepts for greenhouse gas capture, separations, reuse and other mitigation, and on geologic CO₂ storage options.

Vision 21 is an extension or continuation of ongoing R&D to lower the cost and dramatically improve the environmental performance and efficiency of coal plants that will lead to the deployment of a family of plants that converts a combination of feedstocks (e.g., coal, natural gas, biomass, opportunity fuels, petroleum residuals, wastes) to electricity, heat (e.g., steam), a suite of high-value products that may include synthesis gas, hydrogen, liquid fuels, chemicals, and by-products (e.g., sulfur and ash or slag). The specific feedstocks and products, and indeed the size and configuration, of each Vision 21 plant will depend on the plant's location, and on the resources, raw materials, and market factors in play at that location. Physically, Vision 21 plants will be an optimally integrated combination of power

I. Mission Supporting Goals and Objectives: ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

and fuels processing subsystems or modules that could include advanced combustors and gasifiers; high-temperature heat exchangers; gas separation, reforming, cleanup, and purification systems; turbines; fuel cells; chemical reactors; and advanced control systems.

Vision 21 plants will effectively remove environmental constraints as an issue in the use of fossil fuels: emissions of traditional pollutants, including smog and acid rain forming species, will be near zero and the greenhouse gas, carbon dioxide, will be reduced 40-50% by efficiency improvements, and reduced to zero if coupled with sequestration. Vision 21 plants will be affordable: costs will be compatible with sustained economic robustness, enhanced industrial competitiveness, and jobs creation through the availability of low-cost energy.

Performance Measures:

The Advanced Clean/Efficient Power Systems Program is developing a suite of technologies aimed at reducing emissions from existing fossil fuel power plants and developing clean high efficiency fossil fueled power plants and innovative options for carbon sequestration for the 21st century energy markets. Achievement of this goal will provide benefits of a 70% reduction in regulated emissions while yielding compliance cost reductions of over \$5 billion/year through 2010 and over \$7 billion/year after 2010. In addition, cost of electricity savings from these advanced technologies could be over \$5 to 15 billion/year through 2030 while increasing the gross domestic product by \$137 billion by 2010 and thereby generating more than 1.4 million job years. On the international front, these cost competitive technologies can by 2030 capture potential international sales of almost \$350 billion, with over 600,000 jobs/year. On the home front, domestic sales are expected to bring almost \$138 billion by 2030 and generate over 350,000 jobs/year. With respect to global climate change, by 2030, more efficient power plants could reduce greenhouse gas emissions globally by 370 million metric tonnes of carbon per year. In addition, CO₂ sequestration options being pursued in this program are expected to reduce U.S. emission by another 250 million metric tonnes of carbon per year.

Activities in FY 2000 in support of this goal include the following:

- Initiate construction of a clean, efficient, advanced coal fired power system -- part of the final phase of the Low Emissions Boiler Program (LEBS) which will be completed in 2001. The system will utilize newly developed high temperature filtration processes for superior environmental performance and will provide the foundation for a new generation of highly efficient supercritical steam power plants.
- Complete subscale testing of high temperature air furnace technology for use in highly efficient, indirectly-fired combustion power systems and in Vision 21 powerplexes.

- Complete initial lab tests of novel gaseous separation (O₂, H, CO₂) technologies to provide options for Vision 21 powerplexes.
- Identify candidate low-cost gas purification technologies to support the zero emissions goal of Vision 21 powerplexes.
- Complete first large-scale (600 MW) tests of selective non-catalytic reduction for cost-effective NO_x control. Utilization or other disposition of coal combustion products from conventional and advanced power plants accepted as common business practice, minimizing public concerns. Complete selection of advanced biological and chemical concepts for exploratory research on carbon conversion to useful products and chemical feedstocks. Complete selection of high potential advanced concepts for CO₂ separation and capture to be tested at scale sufficient to obtain engineering and environmental data required for development. Begin pilot program to test and confirm geological sequestration technologies.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Advanced Pulverized Coal-Fired Powerplant . .	\$15,689	\$15,000	\$3,000	\$-12,000	-80%
Indirect Fired Cycle	4,833	6,500	7,010	510	8%
High Efficiency - Integrated Gasification Combined Cycle	21,885	32,388	38,661	6,273	19%
High Efficiency - Pressurized Fluidized Bed . . .	17,540	14,638	12,202	-2,436	-17%
Advanced Research and Environmental Technology	<u>12,473</u>	<u>19,150</u>	<u>23,864</u>	<u>4,714</u>	<u>25%</u>
Total, Advanced Clean/Efficiency Power Systems	<u>\$72,420</u>	<u>\$87,676</u>	<u>\$84,737</u>	<u>\$-2,939</u>	<u>-3%</u>

II. B. **Laboratory and Facility Funding Schedule:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Oak Ridge National Lab	\$0	\$50	\$50	\$0	0%
Argonne National Lab (East)	0	1,500	100	-1,400	-93%
Federal Energy Technology Center	14,044	13,006	11,740	-1,266	-10%
All Other	<u>58,376</u>	<u>73,120</u>	<u>72,847</u>	<u>-273</u>	<u>0%</u>
Total, Central Systems	<u>\$72,420</u>	<u>\$87,676</u>	<u>\$84,737</u>	<u>\$-2,939</u>	<u>-3%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Pulverized Coal-Fired Powerplant	Begin Phase IV which includes the construction and operation of a proof-of-concept facility. Goal is 42% efficiency, SO2 and NOx emissions less than 1/6 NSPS and minimal solid waste. Cost sharing of 50% required for Phase IV. (\$14,813). Implement customer service activities (\$85). Co-firing of coal and hospital wastes (\$630) (Total \$15,528) (Donlee Technologies, TBD)	Continue Phase IV which includes the construction and operation of a proof-of-concept facility. Goal is 42% efficiency, SO2 and NOx emission less than 1/6 of NSPS and minimal solid waste. Cost sharing of 50% required in Phase IV. (\$14,765) Implement customer service activities (\$85) (Total \$14,850) (DB Riley, TBD)	Continue Phase IV which includes the construction and operation of a proof-of-concept facility. Goal is 42% efficiency, SO2 and NOx emission less than 1/6 of NSPS and minimal solid waste. Cost sharing of 50% required in Phase IV. (\$2,970) (DB Riley, TBD)
	Fund technical and program management support. (\$161)	Fund technical and program management support. (\$150)	Fund technical and program management support. (\$30)
	\$15,689	\$15,000	\$3,000

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Indirect Fired Cycle	<p>Continue HIPPS Phase II engineering development and testing of components and sub-systems. Goal is 47% efficiency, SO₂ and NO_x emissions less than 1/10 NSPS, and generation of usable by-products in lieu of wastes. Cost-sharing minimum of 25% required for Phase II. (\$3,408) (Foster Wheeler, UTRC)</p> <p>Continue FETC in-house research on combustion mechanisms and pollutant formation/suppression/removal in highly turbulent flows for application to HIPPS technology (\$950). Fund project management support (\$376) and customer service (\$50). (Total \$1,376) (FETC, TBD)</p> <p>No activity. (\$0)</p>	<p>Refocus HIPPS development on those components and subsystems that are part of the Vision 21 plant. (\$4,909) (Foster-Wheeler, UTRC)</p> <p>Continue FETC in-house research on combustion mechanisms and pollutant formation/suppression/removal in highly turbulent flows for application to HIPPS technology (\$1,100). Project management (\$376). Customer service (\$50). (Total \$1,526) (FETC, TBD)</p> <p>No activity. (\$0)</p>	<p>Continue HIPPS development on those components and subsystems that are part of the Vision 21 plant. (\$4,414) (Foster-Wheeler, UTRC, FETC, TBD)</p> <p>Continue FETC in-house research on combustion mechanisms and pollutant formation/suppression/removal in highly turbulent flows for application to HIPPS technology (\$1,100). Project management (\$376). Customer service (\$50). (Total \$1,526) (FETC, TBD)</p> <p>Conduct Vision 21 critical combustion and high temperature furnace modules development and systems design. (\$1,000) (Foster-Wheeler, UTRC, TBD)</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Indirect Fired Cycle (Cont'd)	Fund technical and program management support. (\$49)	Fund technical and program management support. (\$65)	Fund technical and program management support. (\$70)
	\$4,833	\$6,500	\$7,010
High Efficiency - Integrated Gasification Combined Cycle	Conduct long-term testing the transport reactor train and the associated hot gas particulate control devices at the Wilsonville Power Systems Development Facility (20% cost share). (\$9,953) (SCS)	Continue development of the transport-bed gasifier and associated hot gas particulate control devices at the Wilsonville Power Systems Development Facility (PSDF). Begin design activities for the construction of a fluid-bed desulfurization reactor (20% cost share). (\$9,610) (SCS)	Activity included under Gasification Systems Technology.
	Continue PDU operation of the novel fluid-bed/transport-regime desulfurizer at FETC to evaluate desulfurization concepts and sorbents. (\$4,417) (FETC/M. W. Kellogg)	Continue PDU operation of FETC's novel fluid-bed/transport reactor to evaluate desulfurization process concepts and sorbents. (\$3,100) (FETC, TBD)	Activity included under Gasification Systems Technology

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)	<p>Continue R&D and testing of novel and advanced sulfur sorbents and systems. Continue in-house testing for advanced sorbent for fluid bed/transport desulfurizers. Complete R&D on advanced direct sulfur recovery concepts. Validate performance of promising hot gas cleanup materials, components, or subsystems in existing or planned pilot or demonstration facilities through slipstream/coupon testing. (\$3,881) (GE, FETC, RTI, TBD)</p> <p>Test identified successful concepts for NO_x reduction for IGCC systems. Investigate advanced concepts for cost effective CO₂ recovery. Continue R&D for characterization and control of alkali and HAPS/trace species in IGCC streams. Complete characterization testing on filter material. (\$1,546) (UNDEERC, TBD)</p>	<p>Continue R&D and testing to develop high capacity, regenerable, attrition-resistant sorbents for use in fluid-bed/transport desulfurization reactors. Initiate project to test the direct sulfur recovery process at the Wilsonville PSDF on coal-derived synthesis gas. Continue development of novel single-step processes for removal of sulfur and ammonia. (\$2,900) (FETC, RTI, GE, TBD)</p> <p>Conduct IGCC design optimization study to obtain firm cost, schedule, and performance data. Continue R&D on the control of alkali and HAP's/trace species. Investigate CO₂ recovery and utilization technologies. Implement customer service activities. (\$3,080) (UNDEERC, FETC, TBD)</p>	<p>Activity included under Gasification Systems Technology.</p> <p>Optimization study and customer service activities included under Systems Analysis/Product Integration. R&D on alkali control, HAPS and CO₂ included under Gasification Systems Technology.</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)	Close-out and dispose of GE integrated fixed-bed gasifier/hot gas cleanup facility. Continue advanced sulfur sorbent systems development. Implement customer service activities. (\$1,865) (GE, HQ)	Conduct innovative approaches for improving plant efficiencies for power and fuels production, thereby reducing greenhouse gas emissions. Conduct work on the development and integration of advanced air separation technologies with gasification and advanced gas turbines (\$4,175) Accelerate the development of high temperature hydrogen membrane separation technologies for integrated IGCC/fuel cell applications (\$1,500). Develop advanced gas cleanup technologies for meeting more stringent gas quality requirements for fuel cell integration (\$2,300). Conduct experimental investigations on biomass gasification and perform system analyses for integration of IGCC/fuel cell/advanced turbines/co-production applications in the pulp and paper industry (\$3,500). Perform experimental testing of cofiring of biomass and municipal	Included under Vision 21. Hydrogen membrane separation; advanced gas cleanup; experimental investigations on biomass gasification and experimental testing of co-firing biomass and municipal wastes included under Gasification Systems Technology. Systems analyses for integration of IGCC/fuel cell/advanced turbines and feasibility studies for co-firing/co-production applications included under Systems Analysis/Product Integration.

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)	No activity. (\$0)	wastes and perform relevant system integration studies. Conduct feasibility studies for cofiring/coproduction applications (\$2,000). (Total \$13,475) (TBD, ANL) No activity. (\$0)	Develop gasification and combustion high efficiency energy complexes with near-zero emissions and CO ₂ management options. Develop advanced air separation technology and integration with advanced gas turbines. Develop of high temperature hydrogen membrane separation technologies for

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)			integrated IGCC/fuel cell applications. Develop advanced gas cleanup technologies for ultra-clean synthesis gas for fuel cell and coproduction applications. Conduct experimental investigations on coal/biomass/waste gasification. Perform system analyses for integration of gasification/combustion/fuel cell/advanced turbines/coproduction applications for achieving Vision 21 goals (\$11,300). Develop advanced fuel cell systems for Vision 21 gasification/combustion applications in conjunction with gas-based fuel cells system development (\$4,950). (Total \$16,250) (APCI, Texaco, ANL, TECO, RTI, TBD)

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)	Included in activities above.	Included in activities above.	<p>Gasification Systems Technology:</p> <p>Gasification - Continue development of the transport gasifier and associated particulate control devices. Expand transport reactor data base to co-feeding coal and other low-cost feedstocks. Continue development of improved refractory and high temperature measurement instrumentation. Gas Cleaning/Conditioning - Extend sorbent development for near-zero discharge of SO_x and NO_x. Develop baseline performance of the fluid-bed/transport desulfurizer PDU and evaluate candidate sorbents. Begin design for a desulfurization unit at PSDF. Continue R&D on NO_x control and HAPs/PM_{2.5} emissions. Product/By-product Utilization - Complete testing of the direct sulfur recovery process at PSDF.</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)	Included in activities above.	Included in activities above.	<p>Continue investigation on improving slag/ash quality and marketability from co-feed operations. (\$18,506) (SCS, UNDEERC, FETC, ANL, RTI, Praxis, TBD)</p> <p>Systems Analysis/Product Integration:</p> <p>Complete IGCC and co-production design optimization. Continue co-production pioneer plant feasibility studies. Complete development of IGCC market strategy. Evaluate process configurations and establish target performance. Conduct product workshops. Facilitate the formation of partnerships and consortia, identify technology needs and requirements, and interact with customers and stakeholders (\$3,524) (FETC, Mitretek, TBD)</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Integrated Gasification Combined Cycle (Cont'd)	Fund technical and program management support. (\$223) \$21,885	Fund technical and program management support. (\$233) \$32,388	Fund technical and program management support. (\$381) \$38,661
High Efficiency - Pressurized Fluidized Bed	Continue evaluating new materials, devices and systems developed in previous work for the purpose of selecting the most promising materials to be tested with the second generation advanced cycle PFBC high efficiency system at the Wilsonville PSDF capable of meeting basic performance requirements for CCT demonstrations. (\$1,500) (TBD)	Continue evaluation of previously selected and developed HGCU barrier filter materials, devices and systems toward refining and validating designs. Continue to focus on development and testing newly selected materials for applicability to HGCU barrier filtration and evaluation of new filter configurations and system designs for PFBC applications with potential to significantly enhance performance and reduce cost relative to first and second generation systems. (\$2,762) (TBD)	Continue evaluation of hot gas cleanup filter materials, and systems to refine and validate designs; evaluate FBC sorbents that reduce consumption with subsequent reduction of CO ₂ with a goal of significantly enhancing performance and reducing cost; perform supporting research such as system dynamics, combustion characterization, and cofiring with carbon neutral fuels in support of Vision 21. (\$4,000) (FETC, TBD)

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Pressurized Fluidized Bed (Cont'd)	Continue testing new materials for applicability to hot gas particulate filtration and evaluation of new filter configuration and system designs with potential to significantly enhance performance and reduce cost relative to first generation PFBC systems. (\$2,200) (TBD)	Included in activity above.	Included in activity above.
	Continue R&D at FETC on PFB dynamics, advanced concepts, combustion characterization and fundamental research to reduce the risks associated with commercialization of this technology. (\$2,746) (FETC)	Continue R&D at FETC on PFB dynamics, advanced concepts, combustion characterization and fundamental research to reduce the out year risks associated with commercialization of this technology. FETC's emphasis in the near term will focus primarily in the HGCU and GT technology areas followed by efforts to attain the year 2010 goals. (\$2,746) (FETC)	Included in activity above.

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Pressurized Fluidized Bed (Cont'd)	<p>Continue customer service activities. (\$250) (TBD)</p> <p>Continue efforts aimed at improvements in environmental performance and efficiency on first and second generation systems. (\$1,000) (FETC)</p>	<p>Continue customer education activities, via future site specific repowering studies. Long term efforts would be to promote repowering of an actual electricity producer's site at minimum cost to the government. (\$154) (TBD)</p> <p>Continue effort aimed at improvements in environmental performance and efficiency with emphasis on assessing emissions with focus on HAPS, control strategies and GT development. Near term spotlight is on HGCU, GT, and coal/feed systems development to meet the year 2005 goals. Cycle improvements through the introduction of other technologies like the Kalina Cycle and super critical steam cycles will be pursued to achieve the year 2010 goals. (\$700) (FETC)</p>	<p>Evaluate advanced systems users by performing site specific repowering studies that promote repowering of an actual electricity producer's site. (\$150) (TBD)</p> <p>Continue to improve environmental performance and efficiency with emphasis on HAPS control strategies and gas turbine integration. Cycle improvements through the introduction of other technologies like Fuel Cells and super critical steam cycles will be pursued to achieve Vision 21 goals. (\$400) (FETC)</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
High Efficiency - Pressurized Fluidized Bed (Cont'd)	<p>Begin operation of Advanced PFB pilot scale project at Wilsonville and initiate shakedown testing of a PFB pilot scale 2nd generation system capable of achieving 43-45% efficiency with cost-sharing of 20% by industry. (\$9,665) (Southern Co. Services)</p> <p>No activity. (\$0)</p> <p>Fund technical and program management support. (\$179)</p> <p>\$17,540</p>	<p>Continue operation of the APFBC pilot scale project at Wilsonville. (\$8,130). (Southern Co. Services, TBD)</p> <p>No activity. (\$0)</p> <p>Fund technical and program management support (\$146).</p> <p>\$14,638</p>	<p>Continue operation of the APFBC pilot scale project at Wilsonville. (\$7,330). (Southern Co. Services, TBD)</p> <p>Explore power systems designs to optimize CO₂ recycle and enrichment for CO₂ capture or reduction. (\$200) (TBD)</p> <p>Fund technical and program management support (\$122).</p> <p>\$12,202</p>
Advanced Research and Environmental Technology	<p>Super Clean Systems: Downselect ongoing NO_x control contracts and initiate Phase 2. (\$1,218) (EPRI, TBD)</p>	<p>Super Clean Systems: Continue ongoing NO_x control projects. (\$1,475) (TBD)</p>	<p>Super Clean Systems: Determine cost and performance of retrofitable NO_x control for superclean systems technologies to meet all Clean Air Act Amendment I and IV requirements. (\$2,500) (TBD)</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Research and Environmental Technology (Cont'd)	Fine Particulate Control/Air Toxics: Continue to improve measurement characterization techniques for toxic emissions from powerplants sites. Continue air toxics control technology development with downselection of contracts from FY 1995 MEGA PRDA. (\$5,221) (TBD)	Fine Particulate Control/Air Toxics: Continue to improve measurement characterization techniques for toxic emissions from powerplants to optimize mercury control technologies for both cost-effectiveness and efficiency; characterize PM _{2.5} particles; develop lower-cost retrofit fine particulate control technology to meet pending new standards. (\$6,750) (TBD)	Fine Particulate Control/Air Toxics: Improve measurement characterization techniques for toxic emissions, especially mercury, and PM _{2.5} from powerplants and other sites to optimize cost and efficiency of control technologies. Develop and field test lower-cost retrofit technology for control of precursor emissions which cause fine particulates. (\$7,150) (TBD)

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Research and Environmental Technology (Cont'd)	<p>Greenhouse Gas Control: Continue efforts to investigate and/or improve the capabilities of technologies to recover, reuse, and/or dispose of CO₂ emissions from coal-fired utility boilers; examine the environmental impacts of various CO₂ sequestration alternatives; continue participation in the IEA Greenhouse Gas R&D program. Select novel concepts projects to examine feasibility of innovative approaches to greenhouse gas mitigation. (\$1,498) (IEA, TBD)</p>	<p>Greenhouse Gas Control: Continue efforts to investigate and/or improve the capabilities of technologies to recover, reuse, and/or store greenhouse gas emissions from coal-based energy systems; examine the technical, economic and environmental impacts of various CO₂ sequestration alternatives; continue participation in the IEA Greenhouse Gas R&D program; continue ongoing exploratory research projects initiated in prior years to mitigate greenhouse gas emissions; continue novel and advanced concepts projects to obtain required engineering and environmental data. (\$5,890) (IEA, TBD)</p>	<p>Greenhouse Gas Control: Continue efforts consisting of exploratory research on advanced and innovative concepts, and/or technology improvements to recover, reuse, and/or store greenhouse gas emissions from coal-based energy systems. Initiate pilot program to obtain data necessary to confirm technical and environmental performance of geologic sequestration. Examine the technical, economic and environmental impacts of various CO₂, CH₄ and N₂O sequestration alternatives. (\$9,126) (IEA, TBD)</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Research and Environmental Technology (Cont'd)	<p>In-House: Continue in-house research and support in the areas of super clean emissions control, air toxics and fine particulate control, and CO₂ control. Provide for customer service and business activities. (\$2,600) (FETC, BRSC)</p>	<p>In-House: Continue in-house research and support in the areas of super clean emissions control, air toxics and fine particulate control, and CO₂ control. Provide for customer service and business activities. (\$3,076) (FETC, BRSC)</p>	<p>In-House: Conduct supporting research in by-product characterization in areas such as emissions control, air toxics and fine particulate control, and CO₂ control and provide for customer service and business activities. (\$3,300) (FETC, BRSC)</p>
	<p>Waste Management:</p> <p>Continue field monitoring of advanced technology byproducts at Clean Coal disposal sites, at surface mine sites and in deep mines for acid drainage abatement to assure these byproducts do not pose a barrier to the deployment of advanced technologies. (\$350) (Radian)</p>	<p>Waste Management:</p> <p>Continue environmental monitoring of completed projects involving advanced power generation technology byproducts at disposal and acid mine drainage abatement sites. (\$140) (TBD)</p>	<p>This activity is included in the overall in-house effort above. (\$0)</p>
	<p>Continue in-house characterization of coal utilization byproducts and maintenance of related data bases. (\$150) (FETC)</p>	<p>Continue in-house characterization of coal utilization byproducts and maintenance of related data bases. (\$108) (FETC)</p>	<p>This activity is included in the overall in-house effort above. (\$0)</p>

III. **Performance Summary:** ADVANCED CLEAN/EFFICIENT POWER SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Research and Environmental Technology (Cont'd)	Continue byproducts disposal minimization efforts, with 50% cost-sharing through the utilization of advanced and clean coal technology residues as by products. Continue advanced byproducts disposal practices demonstrations. (\$1,309) (TBD)	Conduct joint industry/government R&D activities to maximize use of coal utilization combustion byproducts; develop novel approaches to utilize waste from flue gas desulfurization; conduct evaluations of low NO _x burner and multi-fuel combustion byproducts for market specifications; facilitate technology transfer. (\$1,520) (TBD)	Conduct joint industry/government R&D activities to maximize use of coal utilization combustion byproducts; develop novel approaches to utilize waste from flue gas desulfurization; conduct evaluations of low NO _x burner and multi-fuel combustion byproducts for market specifications; facilitate technology transfer. (\$1,550) (TBD)
	Fund technical and program management support. (\$127)	Fund technical and program management support. (\$191)	Fund technical and program management support. (\$238)
	\$12,473	\$19,150	\$23,864
Advanced Clean/ Efficient Power Systems, Total	\$72,420	\$87,676	\$84,737

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT

I. **Mission Supporting Goals and Objectives:**

The Advanced Research and Technology Development funds two types of activities. The first is a set of crosscutting studies and assessment activities in environmental, technical and economic analyses, coal technology export and international program support. The second is a set of crosscutting fundamental research programs which include coal utilization science, materials and components, bioprocessing of coal and university-based coal research. The second set of programs includes an activity focused upon Historically Black Colleges and Universities (HBCU) and other minority institutions and addresses the full spectrum of fossil utilization research and development, technology transfer, outreach, and private sector partnerships.

In the crosscutting studies and assessments subprograms, the thrusts of international program support, environmental activities, coal technology export, and technical and economic analysis are to complement and enhance all Fossil Energy endeavors by providing both financial and technological leverage. International involvements are limited to those selected areas where it has been determined that the U.S. will benefit at least to the extent it gives on a quid pro quo basis. FE, through these activities, always attempts to encourage the leveraging of research and development funds while protecting U.S. industrial interests and to use them as opportunities to achieve responsible international consensus and opinion on technical business assessment and policy issues.

The crosscutting fundamental research programs focus upon developing the technology base in the enabling science and technology areas that are critical to the successful development of both superclean, very high efficiency coal-based power systems and coal-based fuel systems with greatly reduced or no net emissions of CO₂. These systems are encompassed in the Vision 21 energyplex. Advanced Research seeks a greater understanding of the physical, chemical, biological and thermodynamic barriers to achieving economic, technologic, and environmental goals and to identify ways to overcome those barriers. The program is unique in that it is directed to specific underlying fundamental scientific and engineering problems closely connected to short-term, mid-term and long-range Fossil Energy objectives.

I. Mission Supporting Goals and Objectives: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT

The Coal Utilization Science subprogram focuses on research pertinent to all coal utilization systems, with specific attention paid to increasing our knowledge of the principal mechanisms that control coal combustion processes. It will address issues affecting the utilization of coal, and its primary thrust is the development of the Vision 21 concept. It will involve novel concepts for CO₂ capture and sequestration, and virtual demonstration plants. It will also include research on instrumentation and diagnostics to support the need for advanced controls and sensors. High performance advanced materials and equipment are essential to advanced coal technologies. Thus, the thrust of the advanced materials subprogram is to develop advanced gas separation and particulate removal technology, as well as to develop solutions to materials performance barriers unique to very high temperature, highly corrosive coal combustion and gasification environments. Exploratory research and innovation to maximize the use of coal in environmentally preferable ways is typified by the bioprocessing of coal subprogram. The focus of the biotechnology program is to produce fuels with significantly lower greenhouse gas content than is currently available and CO₂ capture and sequestration. The thrust of the university coal research and HBCU education and training subprograms is to support competitively awarded research grants to universities.

Performance Measures:

The Advanced Research and Technology Development Program is developing the scientific knowledge base for the development of revolutionary technologies and processes with the potential for substantial improvements and advances in power, environmental, and fuel systems, and that will be an integral part of meeting the coal and power systems strategic goals.

Activities in FY 2000 that contribute to this ultimate goal include:

- Completing development of high-temperature iron aluminide filters and proceeding into pilot scale gasification testing.
- Developing low-cost organic membranes for advanced power systems applications such as H₂ separation and O₂ production.
- Demonstrating performance and cost effectiveness of mineral sequestration of CO₂ at larger scale to verify lab scale results.
- Completing the lab-scale work on the biofiltration of NO_x compounds from combustion streams and initiating scale up efforts.
- Developing Innovative Options for 21st Century Energy Markets by initiating development of biological CO₂ sequestration by conversion into useful products such as alternative fuels.

II. A. **Funding Schedule:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
COAL					
Coal Utilization Science	\$3,000	\$4,330	\$6,250	\$1,920	44%
Technology CrosscutMaterials					
Coal Technology Export	847	845	845	0	0%
Bioprocessing of Coal	<u>985</u>	<u>1,082</u>	<u>1,350</u>	<u>268</u>	<u>25%</u>
Subtotal, Technology Crosscut	1,832	1,927	2,195	268	14%
University/National Laboratory Coal Research					
University Coal Research	<u>2,839</u>	<u>2,907</u>	<u>3,000</u>	<u>93</u>	<u>3%</u>
Subtotal, University/National Laboratory Coal Research	<u>2,839</u>	<u>2,907</u>	<u>3,000</u>	<u>93</u>	<u>3%</u>
Subtotal, COAL	7,671	9,164	11,445	2,281	25%
CROSSCUTTING					
Materials and Components					
Materials	5,088	6,225	7,000	775	12%
Components	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0%</u>
Subtotal, Materials and Components	5,088	6,225	7,000	775	12%
Technology Crosscut					
Environmental Activities	2,219	2,200	2,000	-200	-9%
Technical & Economic Analyses	775	700	750	50	7%
International Program Support	<u>651</u>	<u>750</u>	<u>1,000</u>	<u>250</u>	<u>33%</u>
Subtotal, Technology Crosscut	3,645	3,650	3,750	100	3%

II. A. **Funding Schedule:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
University/National Laboratory Coal Research HBCUs, Education and Training	<u>908</u>	<u>900</u>	<u>1,000</u>	<u>100</u>	<u>11%</u>
Subtotal, University/National Laboratory Coal Research	<u>908</u>	<u>900</u>	<u>1,000</u>	<u>100</u>	<u>11%</u>
Subtotal, CROSSCUTTING	<u>9,641</u>	<u>10,775</u>	<u>11,750</u>	<u>975</u>	<u>9%</u>
Total, Advanced Research and Technology Development	<u>\$17,312</u>	<u>\$19,939</u>	<u>\$23,195</u>	<u>\$3,256</u>	<u>16%</u>

II. B. **Laboratory and Facility Funding Schedule:**

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$1,095	\$1,055	\$982	\$-73	-7%
Idaho National Engineering Lab	325	325	325	0	0%
Federal Energy Technology Center	1,607	2,400	2,400	0	0%
Oak Ridge National Lab	4,195	3,935	3,935	0	0%
Oak Ridge Operations Office	3	0	0	0	0%
Pacific Northwest Lab	740	693	693	0	0%
Los Alamos National Laboratory	235	300	500	200	67%
Sandia National Laboratories	300	300	400	100	33%
Ames National Laboratory	90	90	40	-50	-56%
All Other	<u>8,722</u>	<u>10,841</u>	<u>13,920</u>	<u>3,079</u>	<u>28%</u>
Total, Advanced Research	<u>\$17,312</u>	<u>\$19,939</u>	<u>\$23,195</u>	<u>\$3,056</u>	<u>15%</u>

III. Performance Summary: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT

Activity	FY 1998	FY 1999	FY 2000
COAL Coal Utilization Science	<p>Continue applied research and generic studies to collect the physics, chemistry and thermodynamic data needed by the developers, manufacturers and users of advanced coal utilization systems. Research will be continued on fundamental coal combustion processes, evolution of contaminants and hazardous air toxics, dust cake cleaning of high-temperature filters, advanced concepts for cofiring and NOx control, the fundamentals of char reactivity and advanced predictive models required by designers and manufactures of advanced power systems. This work supports Combustion 2000 and other advanced power systems. (\$2,970) (FETC, PETC, SNL, B&R, MIT, Comb. Inst., TBD, UNDEERC, AFR, ANL, BNL, Adelphi Univ.)</p>	<p>Redirect research toward the Grand Challenges of the Virtual Demonstration Plant and CO₂ capture, sequestration, and CO₂ offset, in support of advanced power and fuels systems. Initiate studies to determine additional data sets necessary to meet the needs of the Virtual Demonstration. Initiate competitive solicitation to develop critical enabling technologies for advanced power and fuel systems, and new concepts that will significantly reduce or eliminate environmental impacts of coal utilization with special focus on greenhouse gases that affect global climate change. Continue research in basic coal combustion processes, evolution of contaminants and hazardous air toxics, fundamental carbon studies, and advanced predictive models. Complete data collection and coding of first generation</p>	<p>Conduct research to enable reduction or elimination of environmental impacts of coal use; focus on greenhouse gases that may affect global climate change. Continue research toward the Virtual Demonstration Plant, CO₂ capture, and sequestration in support of Vision 21 power and fuels complex. Conduct systems analysis of Vision 21 concepts to identify critical research areas. Implement projects to develop critical enabling technologies for advanced power and fuel systems in support of Vision 21 and incorporate the results into the Virtual Demonstration. Continue research in basic combustion, contaminant evolution, fundamental carbon studies, and predictive models. Continue research on mineral sequestration of CO₂. (\$6,187) (FETC, SNL, MIT, TBD)</p>

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
COAL Coal Utilization Science (Cont'd)	<p>Fund technical and program management support. (\$30)</p> <p>\$3,000</p>	<p>structurally-based char reactivity model for predicting levels of unburned carbon resulting from low NO_x combustion. Discontinue coal slurry combustion work and transfer the technology to the appropriate line program. Conclude study of ash effects on char reactivity and continue laboratory study of low NO_x mechanisms. Address CO₂ issue by preparing phase I biomass cofiring guidelines . (\$4,287) (FETC, SNL, MIT, Brown U, TBD)</p> <p>Fund technical and program management support. (\$43)</p> <p>\$4,330</p>	<p>Fund technical and program management support. (\$63)</p> <p>\$6,250</p>

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
COAL Technology Crosscut - Coal Technology Export	<p>Support the U.S. efforts with the World Energy Council (WEC). Continue efforts in the Pacific Rim including sharing best practice information with utilities. Continue ongoing projects in the African Region. Develop collaborative R&D projects with Russia and Italy. Implement cooperative activity with India. Continue to regionalize cooperation and energy production in the Black Sea Region and Near East. (\$847) (TBD)</p>	<p>Continue efforts to support deployment of cleaner coal and power generation systems internationally. Pursue opportunities identified by the Houston Conference on the Strategic Value of Clean Fossil Fuel Systems for the international sale of U.S. clean coal technologies and continue efforts to develop collaborative environmental partnerships among major developing nations, U.S. states and local governments, NGO's and industry to support regional efforts to promote the increased use of cleaner power systems. Continue efforts in the Pacific Rim including sharing best practice information with utilities. (\$845) (TBD)</p>	<p>Sustain continued support to deploy cleaner coal and power generation systems internationally. Continue pursuit of opportunities identified by the World Energy Council Working Group on the Strategic Value of Cleaner Fossil Fuel Systems for the international sale of U.S. clean coal technologies and advanced power systems; and maintain efforts to develop collaborative environmental partnerships among major developing nations, U.S. states and local governments, NGO's and industry to support regional efforts to promote the increased use of cleaner power systems. Preserve the efforts in the Pacific Rim including sharing best practice information with utilities. (\$845) (TBD)</p>
	\$847	\$845	\$845

III. **Performance Summary:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
COAL Technology Crosscut - Bioprocessing of Coal	Continue research at lower level on bioprocessing of coal. Continue a reduced number of industry/National Lab collaborative projects on applications of biotechnology to coal conversion and utilization, with special emphasis on involvement of small/emerging companies. (\$975) (ORNL, INEL, TBD)	Develop processes for fuels that have a significantly lower unit content of greenhouse gases (carbon) than currently available fuels to reduce the impact on global climate change. Continue research on novel coal bioconversion processes to enhance economics and environmental acceptability of coal. Investigate the use of electrochemically supplied electron carriers in synthesis gas fermentations. Develop biofiltration system for removal of NO _x from combustion gas streams. (\$1,071) (ORNL, INEL, TBD)	Develop biological processes to reduce CO ₂ production and to sequester CO ₂ . Evaluate electrochemically supplied electron carriers in synthesis gas fermentations and biofiltration for removal of NO _x from combustion gases. Develop biological CO ₂ sequestration by conversion into useful products such as liquid fuels and investigate global, natural CO ₂ mitigation strategies such as whittings and ocean scale algae sequestration. (\$1,336) (ORNL, INEL, TBD)
	Fund technical and program management support. (\$10)	Fund technical and program management support. (\$11)	Fund technical and program management support. (\$14)
	\$985	\$1,082	\$1,350
COAL Technology Crosscut, Subtotal	\$1,832	\$1,927	\$2,195

III. **Performance Summary:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
<p>COAL University/National Laboratory Coal Research - University Coal Research</p>	<p>Support approximately 12 colleges and universities to perform research in four focus areas. Collaborative fundamental research will be emphasized by requiring that all grant recipients in a single focus work cooperatively. Also, joint proposals (university/university, university/industry, minority university/majority university) will be encouraged under each focus area to promote multi-disciplinary, cross-cutting approaches. Under an Innovative Concepts subprogram, provide support to an additional 10 colleges and universities to explore the creative application of ideas and techniques developed in other technological areas to those problems facing the coal research community. (\$2,810) (TBD)</p>	<p>Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and identify breakthrough technologies for the next century, and address scientific and technological issues that are key to achieving FE's strategic objectives. Increase the number of critical key research areas while ensuring the research efforts remain focused to accelerate the identification of solutions for energy and environmental problems associated with global climate change. Collaboration through joint proposals involving university and industry teams will continue. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas that will assist in developing breakthrough technologies for coal utilization. (\$2,878) (TBD)</p>	<p>Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and identify breakthrough technologies for the next century; focus on scientific and technological issues that are key to achieving FE's strategic objectives; and increase the number of critical key research areas to include global climate change. Collaboration through joint proposals involving university and industry teams will continue. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas that will assist in developing breakthrough technologies for coal utilization. (\$2,930) (TBD)</p>

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
COAL University/National Laboratory Coal Research - University Coal Research (Cont'd)	No activity. (\$0)	No activity. (\$0)	Support the undergraduate internship program to allow those junior-level science and engineering majors to experience fundamental research in the areas of environmental science and engineering, and energy, where no graduate course or degrees are offered in their major field of study. (\$40) (TBD)
	Fund technical and program management support. (\$29)	Fund technical and program management support. (\$29)	Fund technical and program management support. (\$30)
	\$2,839	\$2,907	\$3,000
COAL, Subtotal	\$7,671	\$9,164	\$11,445

III. **Performance Summary:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
CROSSCUTTING Materials	<p>Continue only the highest priority elements of the high temperature structural ceramic composites, alloys and functional materials developments that are the most essential to the development of more economic, clean and efficient advanced fossil power systems. These include high temperature intermetallic alloys and corrosion resistant coatings; ceramic composite heat exchanger NDE methods, fabrication processes and design methods; high temperature filters; fuel cell and gas separation inorganic membrane/ electrolyte materials and fabrication processes and carbon composite molecular sieves. (\$5,036) (ANL, INEL, PNL, ORNL, ORO)</p>	<p>Continue those essential activities of the high temperature structural ceramic composites, alloys, and functional materials developments that are enabling elements for the development of economical, high efficiency, and environmentally clean fossil energy power systems. These include the high- and very high-temperature intermetallic alloys and oxidation/sulfidation resistant coatings; fabrication processes; high temperature filters; gas separation ceramic membranes; solid state electrolytes; and carbon fiber composite molecular sieves. Continue support of high priority activities that contribute substantially to the efficiency of advanced power systems, including ceramic composite heat exchangers, nondestructive evaluation techniques, fuel cells; and oxide dispersion strengthened iron aluminides. (\$5,173) (ANL, INEL, ORNL, PNL, ALRC)</p>	<p>Continue those essential activities of the high temperature structural ceramic composites, alloys, and functional materials developments that are enabling elements for the development of economical, high efficiency, and environmentally clean fossil energy power systems. These include resistant coatings; fabrication processes; filters; ceramic membranes; solid state electrolytes; activated carbon fibers; ceramic composite heat exchangers; non-destructive evaluation techniques, high- and very-high temperature intermetallics, and oxide-dispersion-strengthened alloys. (\$5,173) (ANL, INEL, ORNL, PNL)</p>

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
CROSSCUTTING Materials (Cont'd)	No activity. (\$0)	Initiate solicitation to support break-through concepts to develop materials capable of achieving very low cost hydrogen and oxygen separation from mixed gas streams. These are critical enabling technologies to be able to deploy advanced fossil energy ultra-clean fuel and power systems. (\$990) (ORNL, PNL, LANL, SNL, ETTP, FETC)	Continue breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stabilizing greenhouse gases. These are critical enabling technologies to deploy Vision 21 energy plants. (\$1,757) (ORNL, PNL, LANL, SNL, ETTP, FETC)
	Fund technical and program management support. (\$52)	Fund technical and program management support. (\$62)	Fund technical and program management support. (\$70)
	\$5,088	\$6,225	\$7,000
CROSSCUTTING Technology Crosscut - Environmental Activities	Continue analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. (\$1,997) (ANL, ICF, Resource Dynamics, ITSO, TMS, ITCORP, PNL, TBD)	Continue analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. (\$1,980) (ANL, ICF, Resource Dynamics, TMS, PNL, TBD)	Continue analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. (\$1,790) (ANL, ICF, Resource Dynamics, TMS, PNL, TBD)

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
CROSSCUTTING Technology Crosscut - Environmental Activities (Cont'd)	Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. (\$222) (TMS)	Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. (\$220) (TMS)	Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. (\$210) (TMS)
	\$2,219	\$2,200	\$2,000

III. **Performance Summary:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
<p>CROSSCUTTING Technology Crosscut - Technical and Economic Analyses</p>	<p>Continue studies supporting multi-year planning, FE strategy and program formulation; conduct contract studies on issues that crosscut FE programs including strategic benefits of new fossil fuel technology; provide analytical support for fossil related Energy Policy Act implementation. Conduct critical studies to identify major challenges, "leapfrog" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. (\$775) (ANL, ICF, EIA, Resource Dynamics, TMS, CO School of Mines, ITCORP, TBD)</p>	<p>Continue studies supporting multi-year planning, FE strategy and program formulation; conduct contract studies on issues that crosscut FE programs including strategic benefits of new fossil fuel technology; provide analytical support for fossil related Energy Policy Act implementation. Conduct critical studies to identify major challenges, "leapfrog" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. (\$700) (ANL, ICF, EIA, Resource Dynamics, TMS, CO School of Mines, ITCORP, TBD)</p>	<p>Continue studies supporting multi-year planning, FE strategy and program formulation; conduct contract studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conduct critical studies to identify major challenges, "leapfrog" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. (\$750) (ANL, ICF, EIA, Resource Dynamics, TMS, TBD)</p>
	\$775	\$700	\$750

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
CROSSCUTTING Technology Crosscut - International Program Support	Continue Fossil Energy's effort with the IEA program. Continue to collaborate with a variety of international organizations to insure the U.S. clean coal interests are represented; and bilaterally to continue to work with countries to assure that cleaner energy technologies are deployed. (\$651) (TBD)	Support Fossil Energy in developing collaborative technical activities with international performers in the coal and advanced power system area. Maintain active relationships with international organizations such as the World Energy Council (WEC) and United States Energy Association (USEA). Join with other coal-using and coal-producing nations in funding expert-level analyses and reviews of coal supplies and characteristics, technology and economics of coal utilization, pathways for mitigation of environmental impacts, and international financing of coal projects and other topics as conducted by the International Energy Agency Coal Research (IEACR) and widely distributed to users in the U.S. Continue support of programmatic efforts in the Pacific Rim and focus on activities	Support Fossil Energy's commitment to the International Energy Agency Program (IEA) effort. Preserve active relationships with international organizations such as the World Energy Council (WEC) and United States Energy Association (USEA). Implement Environmental Corps activities in conjunction with the U.S., China Energy and Environmental Center function. Initiate cleaner energy technology activities in Russia, Newly Independent States formerly of the Soviet Union and Southern and Western regional African countries. Assessment and assistance of near and middle east, other regions and U.S. industry-International Outreach. Determine opportunities for power systems in targeted countries. (\$1,000) (TBD)

III. **Performance Summary:** ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Technology Crosscut - International Program Support (Cont'd)		in China. Initiate Environment Corp activities in conjunction with the U.S. China Energy and Environmental Center function. (\$750) (TBD)	
	\$651	\$750	\$1,000
CROSSCUTTING			
Technology Crosscut, Subtotal	\$3,645	\$3,650	\$3,750
CROSSCUTTING University/National Laboratory Coal Research - HBCUs, Education and Training	Support an expanded HBCU annual technology transfer symposium (to include other minority institutions) and research activities (8 to 10 awards) (open competition to 117 HBCUs and other minority institutions). (\$899) (TBD)	Support an expanded HBCU annual technology transfer symposium (to include other minority institutions) and research activities (8 to 10 awards) (open competition to 117 HBCUs and other minority institutions). (\$890) (TBD)	Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. (\$990) (TBD)
	Fund technical and program management support. (\$9)	Fund technical and program management support. (\$10)	Fund technical and program management support. (\$10)
	\$908	\$900	\$1,000
CROSSCUTTING, Subtotal	\$9,641	\$10,775	\$11,750

III. **Performance Summary**: ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Research and Technology Development, Total	\$17,312	\$19,939	\$23,195

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

NATURAL GAS RESEARCH

I. **Mission Supporting Goals and Objectives:**

Current Situation: Natural gas consumption in the United States is projected to reach or exceed 30 Tcf per year by 2010, increased from 22 Tcf in 1997 (projections of EIA, GRI, Enron). Reduced emissions targets for greenhouse gases could lead to a 40 Tcf gas market by 2010. Gas will play a key role in the 21st century transition to a post-oil economy for transportation fuels. Most of the domestic gas resource base is not yet fully known (“immature”) and is located in such areas as: deep formations, gas-bearing shales, below basalt formations, hydrates, deep water, remote areas --Gulf of Mexico and Alaska, coalbed methane, and landfill gas. However, the resource base is expanding with progress in geologic knowledge and advanced exploration and recovery technology. Underinvestment in research will cause scarcity in economic gas supplies, but it will not be because of an inadequate resource base.

National Issues and Drivers:

- A **secure supply of reasonably priced energy** is a prerequisite to U.S. economic strength in the global economy.
- Gas accounts for **one-third of total U.S. energy consumption** (consumption is projected to increase despite energy efficiency improvements).
- **Growing energy demand will increase U.S. dependence on petroleum and gas imports** (imports are projected to grow to 68 percent of crude oil supply by 2015, and imported oil is the largest factor in the negative U.S. trade balance - gas imports will increase from about 3 TcP in 1997 to about 4.6 TcP in 2015).
- Development of **advanced gas technologies** is essential to efficiently optimize the production of domestic energy resources, and to enable the clean processing and use of lower quality domestic gas, and to enhance the deliverability of natural gas.
- **Global competition** is causing the gas industry to curtail basic and applied RD&D (industry RD&D spending fell 22 percent from 1994 to 1996, expenditures are shifting toward near-term product and technical services).
- Advanced technologies are critical to sustaining high paying industry jobs and continued **global leadership in technology** (the petroleum industry employs over 300,000 directly and supports as many as a million more throughout the economy, and U.S. exports account for 40 percent of the world's petroleum equipment and services).

I. Mission Supporting Goals and Objectives: NATURAL GAS RESEARCH (Cont'd)

Program drivers for the Natural Gas Research Program: Departmental and Program strategic plans; recommendations of the President's Committee of Advisors on Science and Technology (PCAST) recommendations (FY 2000 budget of \$40 million for gas production/processing technologies and funds to develop a science-based methane hydrates program); the "Comprehensive National Energy Strategy" (CNES); stewardship of Federal lands; environmental protection; the "Domestic Natural Gas & Oil Initiative" (DNGOI); and recommendations of the National Petroleum Council. A key environmental goal of the 1998 Office of Fossil Energy Strategic Plan is to support R&D policies and improved regulatory practices that can moderate future price increases and fuel 25 percent of the anticipated 6 Tcf increase in domestic natural gas production through 2010.

Federal Roles and Responsibilities: Federal roles and responsibilities in natural gas research are to help to: (1) ensure reliable energy supplies at reasonable costs; (2) provide strategic guidance for national energy policy; (3) support efficient and sustainable use of domestic energy resources; (4) protect the environment and public safety; (5) enhance the value of Federal lands (37% of gas production on Federal lands); (6) enhance global market opportunities for U.S. energy technologies; (7) contribute to U.S. science and technology leadership; and (8) apply a unique national perspective to technology development that is independent of company specific on State-specific interests.

DOE's Role In Gas RD&D: Support national goals to: (1) enhance the efficiency and environmental quality of domestic gas exploration, recovery, and processing operations; (2) focus on high-risk technology that private companies alone won't undertake; (3) provide scientific and technological information and analysis to assist policymakers in their decision making; and (4) contribute to science based improvements in regulations to reduce uncertainties and costs while achieving optimal environmental protection.

The overall goal of the Natural Gas RD&D Program is to improve the Nation's ability to supply, store, transport, distribute, and utilize gas in an economic, efficient, and environmentally beneficial manner. In support of DOE's mission the program funds activities that contribute toward: lowering costs for finding and producing gas; improving the confidence in continued availability of a long-term gas supply; increasing the efficiency of recovery from existing reservoirs (Exploration and Production Area); increasing consumer benefits and reduce costs of existing underground storage facilities, and future alternative storage facilities (Delivery and Storage); improving the quality and utility of natural gas for the consuming public (Emerging Processing Technology Area); developing and ensuring availability of low cost environmental compliance technology, and reducing regulatory barriers to economic and efficient market operations by promoting coordinated and innovative Federal and State regulations (Effective Environmental Protection Area). Each program area has its own unique mission that contributes to the goals and mission of the overall Natural Gas Research Program. The

I. Mission Supporting Goals and Objectives: NATURAL GAS RESEARCH (Cont'd)

total program will increase the value of the natural gas resource base for gas consumers, for Federal, State, and local governments and for the gas industry.

The key areas of this program are: (1) Exploration and Production; (2) Delivery and Storage; (3) Effective Environmental Protection; and (4) Emerging Processing Technology Applications. The DOE Federal Energy Technology Center (FETC) located in Morgantown, West Virginia, manages gas technology program implementation activities.

Exploration and Production: The Office of Fossil Energy will continue to fund basic and applied RD&D. Specifically, in the Advanced Drilling Completion, and Stimulation program funding is requested to: develop and demonstrate a set of tools and techniques that will: (a) result in minimum damage during the drilling, completion, and fracturing stages to particular formations; (b) reduce the cost and improve the effectiveness of gas recovery from mature fields; and (c) minimize overall need for drilling-related operations and waste disposal. In the Advanced Diagnostics & Imaging Systems Program (formerly Low Permeability Formations and Resources & Reserves Assessment) funding is requested to develop and demonstrate advanced imaging and prediction techniques for locating productive areas within low-permeability and fractured reservoirs. In addition, the product line funding is requested to identify and assess the potential productivity of deep gas reservoirs in priority basins to reduce exploration and production risks. In addition, a new activity will be initiated; i.e., gas hydrate diagnostics to locate deposits offshore for subsequent assessment of gas supply potential, and gas hydrate characterization from onshore and offshore environments. The Office will also continue to support the Secondary Gas Recovery project for increasing recovery efficiency and for extending the productive life of mature fields. A stripper gas well enhancement sub-program is attempting to extend the productive life of active low rate wells (currently contributing 5% of the domestic gas supply). Finally, technology transfer activities will be continued using the industry managed information to independent producers via newsletters and workshops.

Delivery and Storage: Advanced technology research and demonstration projects are directed to increase the consumer benefits from existing underground storage facilities, reduce the investment required to maintain effective economic storage service, and to provide alternative storage facilities required for the development of new storage capacity. Efforts are focused to develop cost-effective technologies and engineering techniques that can determine well damage mechanisms and prevent or remediate storage field deliverability decline, expand peaking storage capacity to meet gas requirements during high demand periods, and to develop real-time storage measurement technologies to reduce uncertainties in storage inventories attributable to storage metering biases.

I. Mission Supporting Goals and Objectives: NATURAL GAS RESEARCH (Cont'd)

There is a growing national need for increased electricity and reduced emissions from electric power generation plants. Electricity demand from both natural gas and coal is projected to increase significantly through the year 2015 to meet increased energy demand in the U.S. and offset the decline in generation from nuclear power (Annual Energy Outlook, 1998). With the low cost of natural gas and relatively low capital requirements for gas-fired capacity compared to coal-fired capacity, natural gas is forecast to nearly triple its share in the electricity generation market from 1995 to 2015. Advanced Turbine Systems (ATS) will be adaptable for use in coal and biomass-fired powerplants such as IGCC, satisfying future needs for high efficiency, fuel-flexible power generation systems. The Energy Information Agency estimates that gas turbines will satisfy up to 81 percent of new electric power demands in the U.S. by the year 2010. The total world market for electric power generation could exceed 1000 GW between now and 2010. Manufacturers' projections suggest that greater than 70 percent of all new power generation equipment installed in the U.S. after the year 2000 will be derived from the ATS program. This represents a domestic market as large as \$5 billion per year after the year 2000. ATS will be the lowest cost producer of electricity with estimated cost of electricity of 2.6 cents per kw-hr. This translates into an estimated \$7.0 billion in electric consumer savings by the year 2015.

- **Growing Environment Concerns:** There is a growing concern worldwide over climate change emissions and the role they play in global warming. ATS provides the cleanest fossil fueled central power generation option which will be commercially available by the year 2002. With emissions of 0.2 lb/MW-hr of nitrogen oxides and 750 lb/MW-hr of carbon dioxide emissions, ATS will save billions of dollars in environmental compliance while significantly reducing greenhouse gases.
- **Enhancing the U.S. Industrial Competitiveness:** Currently U.S. turbine manufacturers annually export more than \$3 billion worth of power generation systems. Maintaining the U.S. technological lead in gas turbines will provide for increased exports and enhance our industrial competitiveness. The U.S. Department of Commerce estimates that every \$1 billion of exports equates directly to 20,000 jobs. More than 60,000 jobs can be accredited to U.S. turbine manufacturers through the export of power generation systems.

Two vendors are developing the utility ATS, General Electric Company (GE) and Siemens. The GE and Siemens Advanced Turbine Systems Combined Cycle promises improved economics of electric power generation with outstanding environmental performance for natural gas and coal-fired applications, achieving 60% efficiency, single digit Nitrogen Oxide (NOx) levels, and a 10 percent reduction in the cost of electricity when compared to current systems.

I. Mission Supporting Goals and Objectives: NATURAL GAS RESEARCH (Cont'd)

ATS performance measures for FY 2000 include:

- Complete validation testing for critical components of advanced utility-scale turbines with over 60 percent efficiency (combined cycles mode) and ultra-low NO_x emissions.
- Initiate advanced gas turbine full speed, no load testing with the second gas turbine manufacturer, which is the last step before demonstration.

Measures beyond FY 2000 include:

- Commercialize utility ATS by the year 2002. This advanced combined cycle turbine system is also the foundation for power modules of the Vision 21 energy plants.
- Adapt ATS to other fuels like coal and biomass by 2005.

Under the ATS program, Technology Base research and development is being conducted to support development of the ATS and maintain U.S. leadership in the gas turbine industry. Under this program, the following activities are ongoing: an industry/university program to support university student internships and collaborative projects and workshops on combustion, materials and heat transfer; U.S. DOE - Federal Energy Technology Center combustion R&D; development of advanced processes for ATS component manufacturing; and evaluation of humid air turbine applications.

Many of the advanced, coal-fired power generation technologies currently being developed or demonstrated incorporate gas turbines. These include Integrated Combined Gasification combined cycles, advanced pressurized fluidized bed combustion, and indirectly fired systems. Systems where injected moisture can boost both power and efficiency include the Integrated Gasification Humid Air Turbine. The fuel flexibility aspect of the program will address the transfer of technology developed under the ATS program to advanced coal and biomass based systems. Systems studies are being performed by the major turbine manufacturers to evaluate the adaptability of the systems for coal, biomass systems, and other fuels to develop the key power modules for Vision 21 power plexes by the 2010-2015 timeframe.

Continued global market growth is projected for gas engines with the deregulation of the electric power industry and with distributed power generation gaining a larger market share. The development of advanced gas heat engines would provide cost-effective products

I. Mission Supporting Goals and Objectives: NATURAL GAS RESEARCH (Cont'd)

to enable engine users to comply with future emissions standards. The development of advanced gas heat engines would provide U.S. manufacturers with advanced competitive gas engines in the global engine market. Compared to current technology, the advanced engines will be at least 30% higher in brake efficiency, 75% lower in NO_x emissions, and be available at reduced cost. The Office of Fossil Energy will meet with the U.S. engine manufacturers to discuss the R&D needs and benefits associated with developing advanced gas engines.

Emerging Processing Technology Applications: The primary focus of these efforts is to develop technologies needed to prepare for transport and/or use natural gas that is low quality in composition and/or in locations remote from conventional pipelines, e.g., Alaska North Slope, and Gulf of Mexico. Subprogram efforts include development of advanced membrane and other separation technologies to enhance hydrogen sulfide (H₂S), carbon dioxide (CO₂), and nitrogen (N₂) removal from raw gas that is below pipeline quality; development of innovative processes to chemically convert natural gas to readily transportable, competitively priced liquid transportation fuels as well as blending agents able to improve the environmental acceptability of petroleum-based fuels; and other advanced efforts to upgrade, concentrate and otherwise prepare natural gas for use. Collaborative program efforts initiated in FY 1998 with Fossil Energy's coal transportation fuels program and Energy Efficiency and Renewable's Heavy Vehicle Technologies and Hydrogen programs in furthering applicable Fischer-Tropsch gas-to-liquids technology and advanced motor vehicle fuel production will continue.

Effective Environmental Protection: Funding for environmental research activities will bring credible scientific information and advanced technologies to address the environmental issues that have been identified by industry, and state and federal regulators as highest priority. In FY 2000, the program will focus on detection and control of air emissions from gas equipment and facilities, treatment of produced water to meet environmental standards, remediation of soils that have been contaminated with hydrocarbons or produced water, treatment and disposal of wastes containing naturally occurring radioactive materials, and other approaches to manage oil and gas field wastes. The program works to lower the cost of effective environmental protection in these environmental issue areas through a combination of risk assessment, technology development, regulatory streamlining, impact analysis, and facilitating dialogue that attempts to achieve consensus among the affected parties on ways to balance the need to develop the nation's energy resources with the maintenance of our environmental values.

I. **Mission Supporting Goals and Objectives:** NATURAL GAS RESEARCH (Cont'd)

Performance Measures:

The Natural Gas Technology Program is developing knowledge and technologies that will increase natural gas production by over 2.3 Tcf per year by 2010. Additionally, environmental operating costs will be decreased by \$6 billion, cumulative, to 2010.

Activities in FY 2000 that contribute to this ultimate goal include:

- Developing a gas upgrading technology that could contribute to the 80% improvement in 2010 economics over conventional techniques.
- Demonstrating a cost effective horizontal well and advanced exploration and stimulation technologies in low permeability natural gas formations for increasing recovery of the 5,000+ TCF resource in the Greater Green River and Wind River Basins
- Successfully field testing a prototype integrated drilling system using a mud actuated downhole-hammer, reducing drilling costs in medium to hard formations.
- Demonstrating a portable, shoulder mounted laser imaging system to detect leaks at refineries and gas processing plants, reducing the costs of leak detection and repair by 50 percent.
- Identifying a site containing gas hydrates suitable for testing the feasibility of methane recovery.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Exploration and Production	\$13,566	\$13,432	\$14,932	\$1,500	11%
Delivery and Storage	967	1,000	1,000	0	0%
Turbines	43,875	44,500	41,808	-2,692	-6%
Emerging Processing Technology Applications	7,716	9,058	7,308	-1,750	-19%
Effective Environmental Protection	<u>3,181</u>	<u>3,017</u>	<u>2,617</u>	<u>-400</u>	<u>-13%</u>
Total, Natural Gas Technologies	<u>\$69,305</u>	<u>\$71,007</u>	<u>\$67,665</u>	<u>\$-3,342</u>	<u>-5%</u>

II. B. **Laboratory and Facility Funding Schedule:** NATURAL GAS RESEARCH (Cont'd)

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$861	\$900	\$800	\$-100	-11%
Idaho National Engineering Lab	800	620	620	0	0%
Lawrence Berkeley Lab	500	600	600	0	0%
Lawrence Livermore National Laboratory	464	500	500	0	0%
Los Alamos National Laboratory	750	500	500	0	0%
Federal Energy Technology Center	3,046	3,155	3,100	-55	-2%
Oak Ridge National Lab	1,700	1,700	1,700	0	0%
Pacific Northwest Laboratory	200	200	200	0	0%
Sandia National Laboratories	539	650	600	-50	-8%
All Other	<u>60,445</u>	<u>62,182</u>	<u>59,045</u>	<u>-3,137</u>	<u>-5%</u>
Total, Natural Gas Research	<u>\$69,305</u>	<u>\$71,007</u>	<u>\$67,665</u>	<u>\$-3,342</u>	<u>-5%</u>

III. Performance Summary: NATURAL GAS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production	<p>Advanced Drilling, Completion, and Stimulation (DCS): Continue support of industry led cooperative research, development, and deployment of reduced-cost products and cleaner, higher efficiency processes. Continue development and field testing of high rate-of-penetration, slimhole, directional, and underbalanced drilling products; and of advanced completion technologies. Continue testing, deployment, and technology transfer of underbalanced drilling technology and minimum formation damage drilling and fracturing. Continue fluid fracture research with the GRI at Oklahoma University. Initiate development of steerable mud hammer drilling and of underbalanced closed loop drilling, and development of a revolutionary drilling system. (\$4,701) (FETC, Smith Int'l, Oklahoma Univ., Sperry Sun, Novatek, PCS/Universal, Drilling Eng'g Assoc., Mauer, Tempress, Tech Int., Penn St., TBD)</p>	<p>Advanced Drilling, Completion, and Stimulation (DCS): Continue support of industry led cooperative research, development, and deployment of reduced-cost products and cleaner, higher efficiency processes. Continue development and field testing of high rate-of-penetration, slimhole, directional, and underbalanced drilling products; and of advanced completion technologies. Continue testing, deployment, and technology transfer of underbalanced drilling technology and minimum formation damage drilling and fracturing. Continue fluid fracture research with the GRI at Oklahoma University. Continue development of a revolutionary drilling system. (\$4,000) (FETC, Oklahoma Univ., EG&G, Maurer/Halburton, Sperry Sun, Drilling Eng'g Assoc., Novatek, Mauer, Tempress, Tech Int., Penn St., TBD)</p>	<p>Advanced Drilling, Completion, and Stimulation (DCS): Continue development and field testing of high rate-of-penetration, slimhole, directional, and underbalanced drilling products; and of advanced completion technologies. Continue testing, deployment, and technology transfer of underbalanced drilling technology and minimum formation damage drilling and fracturing. Continue fluid fracture research with the GRI at Oklahoma University. Continue development of a revolutionary drilling system. (\$4,270) (FETC, Oklahoma Univ., Sperry Sun, Drilling Eng'g Assoc., Novatek, Mauer, Tempress, Tech Int., TBD)</p>

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Exploration and Production (Cont'd)	<p>Low Permeability Formations: Continue research in low-permeability reservoir field deployment with industry in the Greater Green River and other priority basins. Continue development of diagnostics for imaging and predicting gas in natural fractured reservoirs, conducting advanced geoscience measurements including seismic processing and interpretation, and use of advanced National Laboratory capabilities. Initiate technology support work for development of gas hydrates program. (\$3,924) (EG&G, LBL, SNL, Coleman, Adv. Res., UPRC, USGS, NRL, Marine Board)</p> <p>Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. (\$964) (LLNL, LANL, INEL)</p>	<p>Low Permeability Formations: Continue research in low-permeability reservoir field deployment with industry in the Greater Green River and other priority basins. Continue development of diagnostics for imaging and predicting gas in natural fractured reservoirs, conducting advanced geoscience measurements including seismic processing and interpretation, and use of advanced National Laboratory capabilities. (\$3,553) (EG&G, LBL, SNL, Coleman, Adv. Res., UPRC, Marine Board, TBD)</p> <p>Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. (\$1,000) (LLNL, LANL, INEL)</p>	<p>Advanced Diagnostics and Imaging Systems (formerly Low Permeability Formations): Continue research in low-permeability reservoir field deployment with industry in the Greater Green River and other priority basins. Continue development of diagnostics for imaging and predicting gas in natural fractured reservoirs, conducting advanced geoscience measurements including seismic processing and interpretation, and use of advanced National Laboratory capabilities. Continue analysis of deep gas potential in priority basins. (\$3,343) (FETC, LBL, SNL, ICF, USGS, Marine Board, TBD)</p> <p>Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. (\$1,000) (National Labs)</p>

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Exploration and Production (Cont'd)	<p>Resources and Reserves: Continue development of natural gas data system for both conventional and unconventional reservoirs. Continue collaboration effort with USGS on US resource/reserve assessments. Continue tests of methodologies in the Appalachian Basin and the offshore Gulf Coast. Support industry led efforts in technology transfer. (\$3,838) (BEG, WV Consortium, PTTC)</p> <p>No activity. (\$0)</p>	<p>Resources and Reserves: Continue development of natural gas data system for both conventional and unconventional reservoirs. Continue collaboration effort with USGS on US resource/reserve assessments. Continue tests of methodologies in the Appalachian Basin and the offshore Gulf Coast. Support industry led efforts in technology transfer. (\$3,745) (BEG, WV Consortium, PTTC)</p> <p>Methane Hydrates Systems: Initiate characterization efforts and seismic surveys for assessment of supply potential. (\$500) (USGS, NRL, Colo. Sch. Of Mines, TBD)</p>	<p>Resources and Reserves/ Secondary Gas Recovery/ Technology Transfer: Continue development of natural gas data system for both conventional and unconventional reservoirs. Continue collaboration effort with USGS on US resource/reserve assessments. Continue tests of secondary gas recovery methodologies in the Appalachian Basin and the offshore Gulf Coast. Support industry led efforts in technology transfer. (\$3,685) (BEG, WV Consortium, PTTC)</p> <p>Methane Hydrates Systems: Initiate resource characterization and seismic survey activities in the onshore and offshore areas. (\$1,985) (TBD)</p>

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Exploration and Production (Cont'd)	No activity. (\$0)	Stripper Wells Revitalization: Conduct engineering assessment of wells to determine candidate areas for restimulation tests; test and evaluate via field tests the effect of revitalization efforts to extend the productive life of the well. (\$500) (TBD)	Stripper Wells Revitalization: Conduct engineering assessment of wells to determine candidate areas for restimulation tests; test and evaluate via field tests the effect of revitalization efforts to extend the productive life of the well. (\$500) (TBD)
	Provide technical and program management support. (\$139)	Provide technical and program management support. (\$134)	Provide technical and program management support. (\$149)
	\$13,566	\$13,432	\$14,932
Delivery and Storage	Continue support to industry for deliverability enhancement, gas measurement and advanced storage concepts. (\$957) (ARI, SWRI, PB-KBB, RE-SPEC, MSU, IGS)	Continue support to industry for deliverability enhancement, gas measurement and advanced storage concepts. (\$990) (ARI, MSU, IGS, TBD)	Continue support to industry for deliverability enhancement, gas measurement and advanced storage concepts. (\$990) (TBD)
	Provide technical and program management support. (\$10)	Provide technical and program management support. (\$10)	Provide technical and program management support. (\$10)
	\$967	\$1,000	\$1,000

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Turbines	<p>Continue the advanced turbine systems ultra high efficiency gas turbine technology program. Continue technology base development including: Univ. consortium, in-house research, manufacturing technologies, combustion and coal application. (\$9,747) (SCERDC, FETC, Prate/Whitney, ORNL, ABB)</p>	<p>Continue the advanced turbine systems ultra high efficiency gas turbine technology program. Continue technology base development including: Univ. Consortium, in-house research, manufacturing technologies, address fuel flexibility application. (\$8,570) (SCERDC, FETC, Pratt/Whitney, ORNL)</p>	<p>Continue the advanced turbine systems ultra high efficiency gas turbine technology program. Continue technology base development including: Univ. Consortium, in-house research, manufacturing technologies, address fuel flexibility application. Conduct advanced cycle studies; conduct assessment of development needs for advanced gas heat engines. (\$8,000) (SCERDC, FETC, Pratt/Whitney, ORNL, TBD)</p>
	No activity. (\$0)	No activity. (\$0)	<p>Vision 21: Investigate flexible midsize turbine configurations for Vision 21 powerplex applications including coproduction. (\$800) (TBD)</p>

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Turbines (Cont'd)	Continue the investment program for Natural Gas through an accelerated advanced turbine systems program. Continue utility system component development efforts. Continue full-scale component/sub-system testing. (\$33,678) (GE, Siemens)	Continue the investment program for Natural Gas through an accelerated advanced turbine system program. Complete full-scale component/sub-system testing and engine manufacturing. Initiate site erection and preparation for full speed test. (\$35,485) (GE, Siemens)	Complete full-scale component/sub-system testing and engine manufacturing. Initiate site erection and preparation for full speed test. Conduct full-speed no-load engine tests and ATS system integration. (\$32,590) (GE, Siemens)
	Provide technical and program management support. (\$450)	Provide technical and program support. (\$445)	Provide technical and program support. (\$418)
	\$43,875	\$44,500	\$41,808
Emerging Processing Technology Applications	Gas-to-Liquids: Monitor gas-to-liquids feasibility factors for remote gas in Alaska, Gulf of Mexico, and other domestic locations. Continue cost-shared development of innovative hydrogen plasma, chemical, and physical conversion technologies for the production of transportable liquids from natural gas. Continue basic exploratory research activities of novel concepts.	Gas-to-Liquids: Monitor and evaluate gas-to-liquids feasibility factors for remote gas in Alaska, Gulf of Mexico and other domestic locations as stand-alone operations and/or with other power or energy conversion technology. Continue basic exploratory research activities of novel conversion concepts. Continue cost-shared development of innovative hydrogen plasma	Gas-to-Liquids: Monitor and evaluate gas-to-liquids feasibility factors for remote gas in Alaska, Gulf of Mexico and other domestic locations as stand-alone operations and/or with other power or energy conversion technology. Continue basic exploratory research activities of novel conversion concepts. Continue cost-shared development of innovative hydrogen plasma

III. Performance Summary: NATURAL GAS RESEARCH (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Emerging Processing Technology Applications (Cont'd)	Continue material, seal, and reactor development of novel ceramic membrane technology for enhancing natural gas utilization in the production of environmentally superior fuels, high-value chemicals and hydrogen. Initiate support activities pertaining to Fischer-Tropsch catalysts and reactor for natural gas conversion to produce environmentally superior liquid fuels. (\$6,185) (INEL, LANL, Cryenco, CANMET, Univ. of OK, LBL, FETC, TBD)	pyrolysis and other chemical conversion, and small-scale physical conversion technologies for the production of transportable liquids from natural gas. Continue material, seal and reactor development of novel ceramic membrane technology for enhancing Fischer-Tropsch gas conversion process to produce environmentally superior liquid fuels and hydrogen. Liquids include low emission, high performance motor vehicle fuel blends at competitive costs and suitable for existing as well as advanced engines under development with DOE/EE program support. (\$6,784) (INEL, LANL-Cryenco, K&M, LBNL, Okla Univ., Air Products, Eltron, Cerametec, ANL, B&W, Arco, Chevron, PNL, Pa. State U., U. of Pa., FETC, TBD)	pyrolysis and other chemical conversion, and continue scaleup and field testing of small-scale physical conversion technologies for the production of transportable liquids from natural gas. Complete material, seal and reactor development, and preliminary reactor design of novel ceramic membrane technology for enhancing Fischer-Tropsch gas conversion process to produce environmentally superior liquid fuels and hydrogen. Liquids include low emission, high performance motor vehicle fuel blends at competitive costs and suitable for existing as well as advanced engines under development with DOE/EE program support. (\$5,302) (INEL, LANL-Cryenco, K&M, LBNL, Okla Univ., Air Products, Eltron, Cerametec, ANL, B&W, Arco, Chevron, PNL, PSU, U. of Pa., CAER, FETC, TBD)

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Emerging Processing Technology Applications (Cont'd)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. (\$388) (GTI)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. (\$318) (GTI)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. (\$318) (GTI)
	Gas Upgrading: Continue research in low-quality gas upgrading, including development of improved sulfur removal processes and development of advanced concepts of readying high nitrogen unmarketable gas for use. Initiate development of advanced hybrid gas separation technologies. (\$1,065) (FETC, Arctech, SNL, MTRI, SRI, IGT, Texas A&M, TBD)	Gas Upgrading: Continue research in low-quality gas upgrading, including development of improved sulfur removal processes and development of advanced concepts of readying high nitrogen unmarketable gas for use. Continue development of advanced hybrid gas separation technologies. Continue multi-strata upgrading and utilization. (\$1,865) (FETC, Arctech, SNL, MTR, SRI, Texas A&M, TBD)	Gas Upgrading: Continue research in low-quality gas upgrading, including development of improved sulfur and CO ₂ removal processes and development of advanced concepts of readying high nitrogen unmarketable gas for use. Continue development of advanced hybrid gas separation and dehydration technologies for onshore and offshore applications. Continue multi-strata upgrading and utilization. (\$1,615) (FETC, SNL, MTR, SRI, Texas A&M, TBD)
	Provide technical and program management support. (\$78)	Provide technical and program management support. (\$91)	Provide technical and program management support. (\$73)
	\$7,716	\$9,058	\$7,308

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Effective Environmental Protection	Program Planning Data Analysis: Continue data collection and the development of analytical tools for program planning, outreach and technology transfer consistent with the Domestic Natural Gas and Oil Initiative, including the capability to quantify environmental costs and assess constraints to gas resource recovery. Perform legislative and regulatory impact analysis related to both upstream and downstream gas environmental issues. (\$425) (ANL, TBD)	Program Planning Data Analysis: Continue data collection and the development of analytical tools for program planning, for outreach and technology transfer, including the capability to quantify environmental costs and assess constraints to gas resource recovery, collection and distribution. Continue to perform legislative and regulatory impact analysis related to both upstream and downstream gas environmental issues. (\$425) (TBD, ICF)	Program Planning Data Analysis: Continue data collection and the development of analytical tools for program planning, for outreach and technology transfer, including the capability to quantify environmental costs and assess constraints to gas resource recovery, collection and distribution. Continue to perform legislative and regulatory impact analysis related to both upstream and downstream gas environmental issues. (\$425) (TBD, ICF)

III. **Performance Summary:** NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Effective Environmental Protection (Cont'd)	<p>Technology Development: Continue efforts to develop and demonstrate technologies and methods for improving the economics and environmental performance of gas exploration, production, operations, processing and transportation including methods that enable operators to define options and costs of alternative environmental compliance strategies application of advanced research and new methods of detecting and controlling air emission from gas equipment and facilities. Continue development of treatment and disposal technologies for NORM and other wastes. Continue cooperative effort to establish scientifically based regulations (\$2,573) (BPF, SELA Univ., SNL, ANL, Greenhill, Univ. of Miss., TBD)</p>	<p>Technology Development: Continue efforts to develop and demonstrate technologies and methods for improving the economics and environmental performance of all facets of gas supply including methods that enable operators to define options and costs of alternative environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions (including particulate matter from gas equipment and facilities). Continue development of treatment and disposal technologies for NORM and other wastes. Continue cooperative efforts to establish scientifically based regulations. (\$2,312) (Greenhill, Natl. Labs, State of Miss., TBD)</p>	<p>Technology Development: Continue efforts to develop and demonstrate technologies and methods for improving the economics and environmental performance of all facets of gas supply including methods that enable operators to define options and costs of alternative environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions (including particulate matter from gas equipment and facilities). Continue development of treatment and disposal technologies for NORM and other wastes. Continue cooperative efforts to establish scientifically based regulations. (\$1,729) (Greenhill, Natl. Labs, State of Miss., TBD)</p>

III. **Performance Summary**: NATURAL GAS RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Effective Environmental Protection (Cont'd)	<p>Outreach and Technology Transfer: Continue outreach and technology transfer efforts on environmental issues affecting natural gas supply, including compliance efforts with industry, states and others to identify and address environmental challenges to expanded natural gas production. (\$150) (IOGCC)</p> <p>Provide technical and program management support. (\$33)</p>	<p>Outreach and Technology Transfer: Continue outreach and technology transfer efforts on environmental issues affecting natural gas supply, including compliance efforts with industry, states, and others to identify and address environmental challenges to expanded natural gas production. (\$250) (IOGCC)</p> <p>Provide technical and program management support. (\$30)</p>	<p>Outreach and Technology Transfer: Continue outreach and technology transfer efforts on environmental issues affecting natural gas supply, including compliance efforts with industry, states, and others to identify and address environmental challenges to expanded natural gas production. (\$437) (IOGCC)</p> <p>Provide technical and program management support. (\$26)</p>
	\$3,181	\$3,017	\$2,617
Natural Gas Technologies, Total	\$69,305	\$71,007	\$67,665

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

FUEL CELLS

I. **Mission Supporting Goals and Objectives:**

Fuel cells are being developed in the near-term for distributed generation applications. In contrast to central systems, distributed systems generally implies smaller-scale production of electric power in stationary plants at or near the end user. Fuel cells as small modular resources may be used on a stand-alone base, or integrated with other units, and even connected to a central system grid. These systems may be owned and/or operated by utilities, utility customers, and third parties.

The impending deregulation and restructuring of the utility industry is accelerated the adoption of distributed power generation in new markets which have higher cost margins than centralized generation. Distributed generation systems like fuel cells potentially offer opportunities for cost-effectively meeting peak demand without the need for capital intensive central station capacity or costly investments in transmission and distribution; they could be used to provide clean power to remote end users; and they could provide new business opportunities to both utility and non-utility owners.

The Fuel Cells program is leveraging technical innovation to develop advanced power systems for distributed generation that will improve power quality, boost system reliability, reduce energy costs, and help delay/defray capital investments. By 2010, distributed generation could emerge as an important segment of the world power-generation market, meeting requirements for higher efficiency and environmental protection and also serving as building blocks to ensure sustainable development in the 21st century. The program goal is to develop ultra-high efficiency modular power systems with lower cost, high quality electricity, significantly lowers carbon emissions, and near zero levels of pollutants.

The objectives of the Fuel Cell System Development/Vision 21 subactivity in support of the Energy Policy Act are: (1) to support technology base development of fuel cell systems to provide highly efficient, environmentally superior technology for the generation of electrical and thermal energy for electric utility, industrial, and commercial/residential markets; and (2) strengthen the national economy by providing technologies that improve U.S. international competitiveness in this new manufacturing industry and by generating export sales for technology/products.

I. Mission Supporting Goals and Objectives: FUEL CELLS (Cont'd)

Strategies to develop clean high efficiency fossil fueled powerplants for the 21st Century include: Near-term (to year 2003) - develop and demonstrate high efficiency, environmentally clean, gas-fueled, multi-kilowatt, fuel cell powerplants, to commercially introduce these powerplants; Mid-term (to year 2010) - develop and demonstrate the advancements in fuel cell technology and combined cycle fuel cell heat engine technology which will enable industry to significantly penetrate broad markets for high efficiency gas-based systems and commercially introduce coal-fueled, multi-megawatt powerplants at competitive costs; Long-term (2010 to year 2030) - develop and demonstrate the critical high risk technology advancements which will permit U.S. industry to establish commercial availability of advanced, ultra-high efficiency, integrated fuel cell systems. Fuel cell systems offer innovative approaches to distributed generation in support of climate change initiatives and are a major part of the Vision 21 concept for distributed and central station applications in the Advanced Power Systems Technology area. Although fuel cell systems have specifically identified goals, these goals dovetail with Vision 21 concepts in the 2010 to 2015 time frame.

These systems offer the prospect of reducing criteria pollutants well below current New Source Performance Standard levels, reducing non-criteria pollutants such as CO₂ and acid rain precursors, and reducing thermal emissions to the environment. These reductions are achieved through the ultra-high efficiency and the inherently low emissions of fuel cell systems. First generation phosphoric acid systems have reached commercial status and market entry units are attempting to overcome cost barriers typical of new products. Higher system efficiencies and lower costs are forecast for advanced molten carbonate and solid oxide fuel cell systems, the second generation systems, which will be introduced using natural gas and later operated on gas and coal in multiple end-use sectors.

The Advanced Research subactivity supports the program objectives by studying critical enabling science and technology topics related to research on fuel cells to lower fuel cell costs, to investigate advanced lower cost and higher performance ceramic fuel cell processes and designs, and to solve fundamental crosscutting materials and design issues, such as seals. The results of the investigations are used by those who develop, design, manufacture and operate fuel cell systems which include the molten carbonate and solid oxide systems discussed above, as well as for the fuel cell/turbine hybrid system. Advanced research of fuel cell power systems seeks to capitalize on their intrinsic high efficiency and their environmentally benign characteristics, emphasizing research on electrochemistry, catalysis, interconnections, and materials interactions for molten carbonate, solid oxide and advanced devices.

The Office of Fossil Energy plans to continue cooperative efforts with the Department of Defense and private industry in actions to accelerate commercialization of fuel cells.

I. **Mission Supporting Goals and Objectives:** FUEL CELLS (Cont'd)

FY 2000 performance measures include:

- Begin testing of first market prototype solid oxide fuel cell at commercial sites for distributed power applications.
- In support of Vision 21, deliver a 1-MW fuel cell/turbine hybrid powerplant to verify market entry design.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Advanced Research	\$1,179	\$1,200	\$1,200	0	0%
Fuel Cell System Development/Vision 21	37,977	41,000	36,449	-4,551	-11%
Mult-Layer Ceramic Technology for Fuel Cells	<u>0</u>	<u>2,000</u>	<u>0</u>	<u>-2,000</u>	<u>-100%</u>
Total, Fuel Cells	<u>\$39,156</u>	<u>\$44,200</u>	<u>\$37,649</u>	<u>\$-6,551</u>	<u>-15%</u>

II. B. **Laboratory and Facility Funding Schedule:**

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$570	\$600	\$600	\$0	0%
Pacific Northwest Lab	290	290	290	0	0%
Oak Ridge National Laboratory	150	0	0	0	0%
Federal Energy Technology Center	556	100	200	100	100%
All Other	<u>37,590</u>	<u>43,210</u>	<u>36,559</u>	<u>-6,651</u>	<u>-15%</u>
Total, Fuel Cells	<u>\$39,156</u>	<u>\$44,200</u>	<u>\$37,649</u>	<u>\$-6,551</u>	<u>-15%</u>

III. Performance Summary: FUEL CELLS (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Advanced Research	<p>This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be continued on molten carbonate and solid oxide electrodes, electrolytes and interconnects; solid oxide advanced concepts, materials and seals; and thin film advanced cell processing techniques. Funding for a cooperative research and development agreement between a national laboratory and a fuel cell manufacturer will be continued. (\$1,167) (ANL, PNL, TBD)</p> <p>Fund technical and program management support. (\$12)</p> <p style="text-align: center;">\$1,179</p>	<p>This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be continued on molten carbonate and solid oxide electrodes, electrolytes and interconnects; solid oxide advanced concept, material and seals; and thin film advanced cell processing techniques. Funding for a cooperative research and development agreement between a national laboratory and a fuel cell manufacturer will be continued. (Total \$1,188) (ANL, PNL, TBD)</p> <p>Fund technical and program management support. (\$12)</p> <p style="text-align: center;">\$1,200</p>	<p>This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be conducted to lower fuel cell costs, to investigate advanced, lower cost and high performance ceramic fuel cell processes and designs, to solve fundamental crosscutting materials and design issues, and to pursue thin film advanced cell processing techniques. (Total \$1,188) (ANL, PNL, TBD)</p> <p>Fund technical and program management support. (\$12)</p> <p style="text-align: center;">\$1,200</p>

III. Performance Summary: FUEL CELLS (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Fuel Cell System Development/ Vision 21	<p>Continue cost-shared cost reduction and performance improvement on a stretched out basis on two systems for market entry by the private sector. Conduct cost-shared cost reduction and product improvement for tubular SOFC for market entry by the private sector. Continue SOFC support at ORNL. (\$36,234) (MC Power, ERC, Westinghouse, ORNL)</p> <p>Continue at a reduced level economic and market study assessments, corrosion studies, electrode life verification, and component development. (\$1,353) (ADL, ANL, ERC, TBD)</p>	<p>Continue cost-shared cost reduction and performance improvement on a stretched out basis on two molten carbonate systems for market entry by the private sector. Continue cost-shared cost reduction and production improvement for tubular SOFC systems for market entry by the private sector. (\$39,540) (MC Power, ERC, Westinghouse, ORNL)</p> <p>Continue at a reduced level economic and market study assessments, system assessments and evaluations, corrosion studies , electrode life verification, and component development. (\$1,050) (ADL, FETC, ANL, TBD)</p>	<p>Continue cost-shared cost reduction and performance improvement on a stretched out basis on two molten carbonate systems and one tubular SOFC system for market entry by the private sector. (\$29,950) (MC Power, ERC, Westinghouse, ORNL)</p> <p>Continue economic and market study assessments, system assessments and evaluations, materials studies, electrode and electrode process development, and low cost component development. (\$1,050) (ADL, FETC, ANL, TBD)</p>

III. **Performance Summary**: FUEL CELLS (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Fuel Cell System Development/ Vision 21 (Cont'd)	Activity previously conducted under Fuel Cells Systems and Advanced Turbine Systems key activity. Continue technical and program management support. (\$390) \$37,977	Activity previously conducted under Fuel Cells Systems and Advanced Turbine Systems key activity. Continue technical and program management support. (\$410) \$41,000	Vision 21: Conduct a Vision 21 enabling cost reduction and performance enhancement program with fuel cell/turbine technologies, such as the tubular SOFC hybrid; investigate advanced ceramic processes and designs; conduct system studies and explore integration issues. (\$5,085) (TBD) Continue technical and program management support. (\$364) \$36,449
Multi-Layer Ceramic Technology for Fuel Cells	No activity. (\$0) No activity. (\$0) \$0	Initiate development of multi-layer ceramic technology for fuel cells (\$1,980) (McDermott) Fund technical and program management support. (\$20) \$2,000	No activity. (\$0) No activity. (\$0) \$0
Fuel Cells, Total	\$39,156	\$44,200	\$37,649

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

OIL TECHNOLOGY

I. **Mission Supporting Goals and Objectives:**

Current Situation: The United States imports more than one-half of the crude oil that the country uses. Seventy-four percent of this imported crude oil comes from politically unstable regions. Two-thirds of the known U.S. oil resource remains unrecovered after conventional production -- a significant target for advanced technologies. The oil well abandonment rate is high -- about 17,000 wells per year -- and much of the U.S. oil resource is prematurely and permanently lost. It is estimated that as much as 80 percent of the U.S. remaining oil resource could be abandoned by 2020 without advanced recovery technologies and cost-effective environmental regulations. Environmental compliance expenditures are causing refinery closures, which could result in the loss of refining capacity of over 10 percent of 15 million barrels per day in less than 5 years.

National Issues and Drivers:

- A **secure supply of reasonably priced energy** is a prerequisite to U.S. economic strength in the global economy.
- Oil accounts for **one-third of total U.S. energy consumption** and **97 percent of transportation fuels** (consumption is projected to increase despite energy efficiency improvements).
- **Growing energy demand will increase U.S. dependence on petroleum imports** (imports are projected to grow to 68 percent of crude oil supply by 2015, and imported oil is the largest factor in the negative U.S. trade balance).
- Development of **advanced oil technologies** is essential to **efficiently optimize the production** of domestic energy resources while **preserving the environment** (advanced technologies are required to slow the decrease in domestic exploration and production of oil and to enable the clean processing and use of lower quality domestic and imported crude).
- The **U.S. is a mature oil-producing region** and domestic oil production is more difficult and more costly than overseas production (an estimated two-thirds of all U.S. oil remains in the ground where much of it is isolated in deep, complex reservoirs or in environmentally sensitive areas -- high costs of operations and environmental compliance are placing U.S. producers at a competitive disadvantage with foreign producers).
- **Global competition** is causing the oil industry to sharply curtail basic and applied RD&D (industry RD&D spending fell 22 percent

I. Mission Supporting Goals and Objectives: OIL TECHNOLOGY (Cont'd)

from 1994 to 1996, expenditures are shifting toward near-term product and technical services, and the Federal government has also cut oil RD&D funding by 35 percent from 1995 to 1997).

- Advanced technologies are critical to sustaining high paying industry jobs and continued **global leadership in technology** (the upstream petroleum sector employs over 450,000 directly and supports as many as a million more throughout the rest of the industry), and U.S. exports account for 40 percent of the world's petroleum equipment and services and thousands of jobs.

Program drivers for the Oil Technology Program are: Departmental and Program strategic plans; recommendations of the President's Committee of Advisors on Science and Technology (PCAST); the "Comprehensive National Energy Strategy" (CNES); environmental protection; the "Domestic Natural Gas & Oil Initiative" (DNGOI); and recommendations of the National Petroleum Council and independent operators through the petroleum Technology Transfer Council. Key energy security goals of the CNES and the 1998 Office of Fossil Energy Strategic Plan are to stop the decline in domestic oil production by 2005 and improve the capability of the Nation's petroleum industry to increase the supply of secure, domestic oil by an average of 500,000 barrels per day during the 2000-2010 period over the 5.5 million barrels per day forecast by EIA, respectively. These goals will be accomplished along with significantly reducing and resolving the environmental issues associated with domestic oil production and processing.

Federal Roles and Responsibilities in Oil Technology Research are to: (1) ensure reliable energy supplies at reasonable costs; (2) provide strategic guidance for national energy policy; (3) support efficient and sustainable use of domestic energy resources; (4) protect the environment and public safety; (5) enhance the value of Federal lands (20% of total oil production is on Federal lands); (6) enhance global market opportunities for U.S. energy technologies; (7) contribute to U.S. science and technology leadership; (8) apply a unique national perspective to technology development that is independent of company specific or state-specific interests; and (9) foster the use of new technology through a nationwide technology transfer network.

The key sections of this program are: (1) Exploration and Production Supporting Research (E&P); (2) Recovery Field Demonstrations; and (3) Effective Environmental Protection (EEP). Program planning and support and technology transfer are integral components of each of the key areas. The DOE National Petroleum Technology Office (NPTO) located in Tulsa, Oklahoma, manages all oil technology program implementation activities.

Because reliable domestic energy supplies are vital to the Nation's economy, this program conducts a range of projects designed to enhance the efficiency and environmental quality of domestic oil operations. These R&D programs are conducted in partnership with

I. Mission Supporting Goals and Objectives: OIL TECHNOLOGY (Cont'd)

universities, State and local governments, industry and other organizations. Private sector participation is emphasized through industry cost-sharing with individual companies and consortia to ensure relevance and to facilitate the transfer of technology to the private sector while leveraging Federal R&D investment.

Exploration and Production Supporting Research consists of Planning and Analysis, Reservoir Efficiency Processes, Advanced Diagnostics and Imaging (ADIS), Technology Transfer, Exploration and Advanced Drilling, Completion, and Stimulation (ADCS), and Multi National Lab/Industry Partnership efforts.

The Planning and Analysis area supports the program by assuring that a strong, continuous dialogue exists with industry and other stakeholders, providing guidance for program planning and evaluation of program results. Effective program planning requires accurate data on the oil resource, supply and utilization trends, industry activities and R&D needs. Legislative, regulatory and policy initiatives in oil supply, environmental and processing must be based on the best available information to support program goals.

The Reservoir Efficiency Processes includes research to develop and demonstrate tools and methodologies that permit oil operators to recover hydrocarbons from known reservoirs not producible by current technology. It also supports university research in extraction technologies and recovery-process modeling to ensure a supply of well-trained workers. The objective is to develop scientific breakthroughs which are applicable to the industry and that benefit the Nation's economy and protect our environmental heritage.

The ADIS work focuses on the development of technologies and methodologies that improve the success rates and cost efficiencies for the development of existing fields and the discovery of new fields. These technologies are required to ensure a longer-term economic supply of domestic oil needed to meet some of the usage projections of nearly 25 million barrels oil per day by 2020 (EIA). Technologies developed in this area are important in the delineation and targeted recovery of an estimated 60 billion barrels of technically recoverable oil within known fields and the discovery and development of an estimated additional 30.3 billion barrels of undiscovered oil within the United States (USGS, MMS). Program goals are to conduct research to develop technologies needed for the development of deeper, higher temperature and geologically more complex reservoirs, thus stimulating domestic production as well as assuring that the U.S. is the worldwide leader in technology in geoscientific diagnostics and imaging systems; resulting in increased technology exports that contribute to high-paying U.S. jobs. Objectives include conducting research to develop and deploy technologies that can provide a refined picture of underground resources and their environments, lowering risk which subsequently results in fewer dry holes, better usage of natural phenomena (such as fractures), and development of more effective well patterns,

I. Mission Supporting Goals and Objectives: OIL TECHNOLOGY (Cont'd)

which can optimize well placement and thus reduce surface damage and the environmental footprint. An additional objective is to enhance oil production from Federal lands through the development and application of technologies that will continue to provide the technical, environmental, and economic justification for the identification, delineation and exploitation of these oil resources.

The technologies are conveyed to industry users through an aggressive technology transfer program. The oil program is a major source of new technology and information for U.S. companies, especially for those that lack technical resources. Much of the technology transfer work is accomplished through the Petroleum Technology Transfer Council with its 10 regional centers.

The ADCS work focuses on developing tools and techniques to drill, complete and stimulate oil wells to produce the 40 billion barrels of oil EIA estimates will be produced domestically by the year 2015. Program goals are to assist industry with developing a balanced portfolio of ADCS technologies that will match the diverse geologic formations, develop new technologies that reduce costs, increase exploration success, minimize formation damage, minimize potential environmental damage, and improve producibility of wells. Other goals are to develop, demonstrate and deploy new technologies that enhance industry acceptance and use of technologies designed to reduce costs and improve productivity of oil wells and to coordinate and collaborate with industry groups to attain these objectives.

The Multi National Lab/Industry Partnership activities represent an industry driven program utilizing a wide range of technologies to effectively produce more of the most difficult oil to recover. Technologies represented include adaptation of defense related technologies and super-computation capabilities for use in the discovery and development work in both new and existing oil and gas field. Activities include 163 partners who are participating in 45 projects in the following areas: oil and gas recovery; diagnostics and imaging; drilling, completion, and stimulation; advanced computational technology; and environmental protection. Projects are reviewed by industry representatives and are at least 50 percent cost-shared.

Recovery Field Demonstrations work focuses on coordinating oil technology activities in research, development, and demonstration of advanced technologies for extraction of hydrocarbons from known (discovered) oil reservoirs. These activities provide improved technology and/or more efficient methods to recover more of the 350 billion barrels of discovered but unproduced domestic oil resource, especially to increase recovery of oil from Federal lands. Funding for laboratory research and evaluation of past advanced field trials directed to incremental recovery potentials in large, promising Class 1, 2, and 3 reservoirs will continue. Efforts in this program will continue to foster improvement in recovery technology to extend reservoir life, improve diagnosis and imaging of reservoirs, and develop drilling, completion and stimulation technologies to support the Nation's economy by applying what has been

I. Mission Supporting Goals and Objectives: OIL TECHNOLOGY (Cont'd)

learned in the various research projects and previous field demonstration work. This new work emphasizes the need for field applications of technology.

The preferred Petroleum Upstream Management Practices (PUMP) program aims to reduce the decline in domestic oil production by 2005, an objective of the Comprehensive National Energy Strategy (CNES). Through the involvement of industry experts, the program is designed to provide short-term supplement to mid- and long-term R&D. PUMP will focus on three technology areas: advanced oil recovery; data management; and effective environmental compliance. The program will focus on integrated and expedited application of these technologies through field demonstrations, best management practices, and resolution of environmental and regulatory constraints. Strategies are threefold: use known technology transfer mechanisms; regional approaches; and integrated solutions to technology, regulatory, and data constraints.

Effective Environmental Protection (EEP) research activities focus on technologies and practices that reduce the threat to the environment and decrease the cost of effective environmental protection and compliance involved in oil exploration and production. The activities in this area are governed by four program elements: risk assessment, regulatory streamlining, technology development, and program planning and analysis. Program goals are to maximize industry recovery, processing, and utilization of U.S. oil resources by reducing the cost of effective environmental protection. The program works to lower the cost of environmental compliance through a combination of risk assessment, technology development, regulatory streamlining, impact analysis, and facilitating dialogue that attempts to achieve consensus among the affected parties on ways to balance the need to develop the Nation's energy resources with the maintenance of our environmental values. In addition, the environmental program's goals are to improve environmental performance, expand the capabilities of State and Federal governments to make more cost-effective, risk-based regulatory decisions, and to improve communication and technology transfer among industry, government, the Native Tribes, and the public toward balancing national energy, economic and environmental objectives.

This oil research program, in partnership with industry and its stakeholders, will maximize discovery of new fields, recovery of the estimated 350 billion barrels of currently unrecoverable oil and develop cutting edge processing technologies. The goals are to better convert this oil into transportation products, develop technologies to minimize waste production and environmental damage and demonstrate the effectiveness of this technology supporting the Nation's energy security and science and technology leadership. Science and Technology Leadership is furthered by the core studies in the areas of extraction technologies, fundamental chemistry, processing, and reservoir characterization. This leadership is also supplemented by teacher training programs, student and faculty

I. **Mission Supporting Goals and Objectives:** OIL TECHNOLOGY (Cont'd)

internships, as well as a broad program of university research. Minority participation in science is addressed by special initiatives for Historically Black Colleges and Universities and Native American Tribes.

Performance Measures:

The Oil Technology Program is developing knowledge and technologies that will increase hydrocarbon production by over 500,000 barrels per day by 2010.

Additionally, environmental compliance costs will be decreased by \$5 billion, cumulative, to 2010.

Activities in FY 2000 that contribute to this ultimate goal include:

- Demonstrating tools and analytical techniques for electromagnetic crosswell reservoir imaging in steel-cased wellbores, allowing monitoring of injected fluid movement in several hundred U.S. projects.
- Completing demonstration and transfer of seven advanced secondary and tertiary technologies, adding 92 million barrels of reserves, increasing the number of economic wells and reducing abandonment rates.
- Completing field testing and monitoring of two technologies for downhole separation for oil and water, resulting in reduction in produced water and potential increase in oil production per well.

II. A. **Funding Schedule:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Exploration and Production Supporting Research	\$30,141	\$30,796	\$31,546	\$750	2%
Recovery Field Demonstrations	5,911	7,800	7,800	0	0%
Effective Environmental Protection	6,224	10,020	10,820	800	8%
Emerging Processing Technology Applications	<u>5,432</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0%</u>
Total, Oil Technology	<u>\$47,708</u>	<u>\$48,616</u>	<u>\$50,166</u>	<u>\$1,550</u>	<u>3%</u>

II. B. **Laboratory and Facility Funding Schedule:**

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$125	\$350	\$400	\$50	14%
Brookhaven National Lab	715	100	400	300	300%
Idaho National Environmental & Engineering Lab	200	478	210	-268	-56%
Lawrence Berkeley Lab	600	690	500	-190	-28%
Lawrence Livermore National Lab	450	579	650	71	12%
Los Alamos National Laboratory	250	300	100	-200	-67%
Oak Ridge National Laboratory	200	500	910	410	82%
Pacific Northwest Laboratory	100	400	200	-200	-50%
Sandia National Laboratories	400	500	450	-50	-10%
All Other	<u>44,668</u>	<u>44,719</u>	<u>46,346</u>	<u>1,627</u>	<u>4%</u>
Total, Oil Technology	<u>\$47,708</u>	<u>\$48,616</u>	<u>\$50,166</u>	<u>\$1,550</u>	<u>3%</u>

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research	<p>Analysis and Planning: Continue technical planning and analysis support. Conduct producibility assessments of major reservoirs, maintain and update the oil resource information base, input and evaluate the data from the Class Program, and continue technical planning and analytical supporting tasks (\$3,486). (IOGCC, M&O, Brashear, TU, TBD)</p> <p>Impact/Oversight/Analysis: Continue project impact/oversight/analysis efforts (\$600). (M&O)</p>	<p>Analysis and Planning: Continue technical planning and analysis support for implementing and evaluating effective and efficient oil research programs. Conduct producibility assessment of major reservoirs, maintain and update the oil resource information base, enhance and maintain metrics capabilities for the Oil Program, enhance and maintain statistical data, models, and supporting systems for effective planning and continue technical and analytical support tasks (\$3,200). (IOGCC, RMC/ Brashear, TRW, TU, TBD)</p> <p>Impact/Oversight/Analysis: Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation (\$600). (RMC)</p>	<p>Analysis and Planning: Continue technical planning and analysis support for implementing and evaluating effective and efficient oil research programs. Conduct producibility assessment of major reservoirs, maintain and update the oil resource information base, enhance and maintain metrics capabilities for the Oil Program, enhance and maintain statistical data, models, and supporting systems for effective planning and continue technical and analytical support tasks (\$3,700). (IOGCC, RMC/ Brashear, TRW, Univ. of Tulsa, TBD)</p> <p>Impact/Oversight/Analysis: Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation (\$600). (RMC)</p>

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	<p>Reservoir Efficiency Processes: Continue reservoir life extension studies such as, foam mechanism research, low-viscosity heavy oil extraction (alkaline), thermal recovery for heavy oil, and advanced recovery technology/ concepts for Schrader Bluff. Conduct research in advanced extraction. Complete the DNGOI acceleration (CRADA BPX), continue MEOR-biotechnology research, recovery processes screening, sweep improvement for gas flooding methods and thermal recovery process for light oil. Conduct a round robin with UNITAR. Continue testing of single well MEOR treatments. Complete studies of target Gulf reservoirs, fund the advanced recovery concepts PRDA. Conduct advanced thermal mechanistic studies. (\$6,400) (LBL/UC, M&O, SUPRI/USC,</p>	<p>Reservoir Efficiency Processes: Continue reservoir life extension studies toward commercialization of the use of foams for the extraction of low viscosity heavy oil and light oil. Continue to advance thermal methods for heavy oil extraction and screen potential heavy oil recovery processes. Continue to enhance thermal methods for light oil recovery through mechanistic studies. Continue to develop MEOR methods to develop surfactant and other oil recovery agents from waste products which helps lower environmental damage from the disposal of these wastes. Continue low cost oil recovery methods using wettability alternations and alkaline-surfactant-polymer (ASP) methods. Continue research to improve the sweep efficiency and recovery efficiency of gas flooding using more environmentally benign</p>	<p>Reservoir Efficiency Processes: Continue the development of state-of-the-art reservoir simulation models and the development scaled down reservoir simulation models for desktop computers. Continue to advance thermal methods for heavy oil extraction and screen potential heavy oil recovery processes. Continue work to improve reservoir sweep for gas flooding, especially for carbon dioxide flooding, by using foams and direct thickeners. Continue the development of microbial flooding techniques by developing genetically modified microbes. Continue to develop MEOR methods to develop surfactant and other oil recovery agents from waste products which helps lower environmental damage from the disposal of these wastes. Continue mechanistic studies to reduce</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	NMIMT, NRC, INEEL, Osage Tribe, USGS/Rice, Stanford, AWU, TBD)	chemicals. (\$5,987) (LBL, INEEL, NMIMT, Stanford, SUPRI, BP CRADA, USGS/Rice, TBD)	surfactant adsorption. Continue to advanced the state-of-the-art in development of new polymers for oil recovery. Continue low cost oil recovery methods using wettability alternations and alkaline- surfactant-polymer (ASP). (\$6,480) (TBD, INEEL, LBL, NMIMT, Stanford, SUPRI, BP CRADA)
	Advanced Diagnostics and Imaging: Continue advanced reservoir imaging and diagnostic systems work including: advanced microseismic mapping, geomechanical influences on reservoir during depletion/repressurization, and EM process sensing with industry for large producing reservoirs. Development of advanced imaging technologies and	Advanced Diagnostics and Imaging: Continue advanced reservoir diagnostic and imaging systems work including, advanced mircoseismic mapping, geomechanical influences on reservoir during depletion/ repressurization, and EM process sensing with industry for large producing reservoirs to optimize oil recovery while minimizing environmental risks. Continue	Advanced Diagnostics and Imaging: Continue advanced reservoir diagnostic and imaging systems work including, advanced mircoseismic mapping, geomechanical influences on reservoir during depletion/ repressurization, and EM process sensing with industry for large producing reservoirs to optimize oil recovery while minimizing environmental risks. Study

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	<p>algorithms, NMRI and Cat-Scan for quantitative analysis of reservoir rock architecture and fluid distribution.</p> <p>Develop/improve technologies for accurate measurement of multiphase relative permeabilities in steady and unsteady state conditions under broad temperature and pressure conditions, and investigate influences of rock-fluid interaction on these critical parameters. Develop integrated geological, geophysical and engineering methods for predicting areal and vertical distribution of reservoir architecture and mobile oil flow patterns, using methodologies for upscaling to the interwell scale for infill drilling and EOR/IOR. Continue fundamental geoscience analysis of naturally fractured</p>	<p>development of advanced imaging technologies and algorithms, NMRI and Cat-Scan for quantitative analysis of reservoir rock architecture and fluid distribution. Develop technologies for accurate measurement of multiphase relative permeabilities in steady and unsteady-state conditions under broad temperature and pressure conditions, and investigate influences of rock-fluid interactions on these critical parameters. Develop integrated geological, geophysical and engineering data and methods for predicting areal and vertical distribution of reservoir architecture and mobile oil flow patterns, using methodologies for upscaling to the interwell scale for infill drilling and EOR/IOR, thus minimizing numbers of infill wells, surface footprints and associated</p>	<p>relationships between seismic and acoustic measurements and reservoir properties; apply results to improved management of oil recovery. Continue development of advanced imaging technologies and algorithms, NMRI and Cat-Scan for quantitative analysis of reservoir rock architecture and fluid distribution. Develop technologies for accurate measurement of multiphase relative permeabilities in steady and unsteady-state conditions under broad temperature and pressure conditions, and investigate influences of rock-fluid interactions on these critical parameters. Develop integrated geological, geophysical and engineering data and methods for predicting areal and vertical distribution of reservoir architecture and mobile oil flow</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Exploration and Production Supporting Research (Cont'd)	reservoirs and geoscience measurements and fund awardees from the fundamental geoscience PRDA. Univ. of KS will continue the Petroleum Atlas Project. (\$6,000) (LLNL, SNL, ORNL, U of Alabama, Stanford, RERI, KU, TBD, M&O, Montana)	environmental effects. Continue fundamental geoscience involving geoscience/engineering reservoir characterization for a variety of reservoir types and depositional environments to optimize field development and management while minimizing environmental exposure. Investigate reservoir pressure/gas saturations, wettability and matrix block size on spontaneous imbibition in fractured reservoirs for improved oil recovery. (\$6,300) (LLNL, SNL, ANL, RERI, TBD, Univ. of Alabama)	patterns, using methodologies for upscaling to the interwell scale for infill drilling and EOR/IOR, thus minimizing numbers of infill wells, surface footprints and associated environmental effects. Continue fundamental geoscience involving geoscience/engineering reservoir characterization for a variety of reservoir types and depositional environments to optimize field development and management while minimizing environmental fractured reservoirs for improved oil recovery. (\$6,050) (LLNL, SNL, ORNL, LBL, Stanford, RERI, TBD)

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	<p>Technology Transfer: Continue outreach to stakeholder groups; transfer results from Class Demonstration Projects to extend reservoir life; continue teacher training programs; increase minority opportunities for summer students; continue program exhibits; improve efficiency of publication, software dissemination. Assist PTTC to implement Phase 2 tech transfer activities. These efforts will meet the needs of major and independent producer, support service industry elements, academic researchers, technical associations, and the public sector. (\$3,123) (M&O, PTTC, TBD, UNITAR, SPE, Univ. of Houston)</p>	<p>Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil producers in extending reservoir life in an environmentally acceptable manner; improve efficiency and coverage in electronic and hardcopy dissemination of publications and software; continue teacher training program for elementary/secondary petroleum energy education; expand schedule of exhibits at professional meetings and upgrade display materials and equipment. These efforts will improve the ability to meet the technological and environmental needs of major and independent producers, support service industry elements, academic researchers, technical associations, and the public sector. (\$3,005) (PTTC, ICHOT, Univ. Of Houston, TBD)</p>	<p>Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil producers in extending reservoir life in an environmentally acceptable manner; improve efficiency and coverage in electronic and hardcopy dissemination of publications and software; continue teacher training program for elementary/secondary petroleum energy education; expand schedule of exhibits at professional meetings and upgrade display materials and equipment. These efforts will improve the ability to meet the technological and environmental needs of major and independent producers, support service industry elements, academic researchers, technical associations, and the public sector. (\$3,005) (PTTC, RMC, ICHOT, SPE, Univ. Of Houston, TBD)</p>

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	<p>Exploration and Advanced Drilling, Completion, and Stimulation: Complete basin analysis in Central Mid Continent in accordance with DNGOI. Continue activities in Native American tribal areas, reduce risk and increase success in finding undiscovered and bypassed oil. Using advanced drilling completion and stimulation systems, improve horizontal well, slimhole drilling and production tools research. Support research in advanced exploration technology by advanced imaging and diagnostic systems and fund awardees in the advanced drilling concepts. (\$3,745) (M&O, LANL, Univ of Tulsa, VA Polytech, WU/JIP, TBD)</p>	<p>Exploration and Advanced Drilling, Completion, and Stimulation: Exploration--Continue to upgrade and expand the current DOE suite of risk based decision-making tools used most by industry. Continue to develop comprehensive detailed lithostratigraphic/climatic models for the development of both clastic and carbonate sedimentary basins by universities, national labs, and industry. Continue the analysis of the Hopi Black Mesa Basin using advanced exploration tools and test new ideas in the next high priority basin (\$2,415). Drilling--Continue the advanced research and high temperature/high pressure experimentation on theology and cuttings transport in energized fluids (gas assisted, foam, mist, etc.) In horizontal and small diameter wellbores using the DOE Flow Loop. Continue research on the more environmentally benign three phase separation technology development for reduced cost</p>	<p>Exploration and Advanced Drilling, Completion, and Stimulation: Exploration-- Continue to upgrade and expand the current DOE suite of risk based decision-making tools used most by industry. Continue development of sedimentary modeling programs using advanced algorithms, including the continued development of comprehensive detailed lithostratigraphic/climatic models including the continued development of comprehensive detailed lithostratigraphic/climatic models integrated sedimentary basin modeling. Continue Basin Analysis and research on the Onshore Gulf of Mexico in Alabama and Mississippi. Continue work with Native American Tribes through targeted research work and training to increase oil recovery efficiency from Tribal lands in an environmentally and culturally</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Exploration and Production and Supporting Research (Cont'd)		improved efficiency on offshore platforms and onshore fields (\$1,565). (Total (\$3,980) (Univ. of Tulsa/LSU, WU, USGS, LANL, Osage Tribe, Hopi Tribe, Alabama, ANL, AU, CalTech, VA Polytech, TBD)	sound manner. Continue work with the Tribes in the Black Mesa Basin (\$2,082). Drilling-- Continue capability upgrades that allow the advanced research and high temperature/high pressure experimentation for prediction of the rheology of and cuttings transport in energized fluids (air, mist, gas assisted, foam, etc.) in horizontal and inclined wellbores using the DOE HP/HT Flow Loop. Continue research on the development of three-phase separation technology that provides for lower costs, improved efficiency, and a reduced footprint on an onshore production pad or offshore platform. Continue development of advanced downhole sensor technology using fiber optics. Continue research in efficiency of well stimulation. Complete project to optimize horizontal well completions. Continue development research on a downhole positive displacement

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	<p>Multi National Lab/Industry Partnership: Develop/adapt/transfer technology that advances understanding of the characteristics and producibility from oil reservoirs, optimizes the performance of production tools and processes, and improves reservoir management resulting in higher oil recovery through leveraging of industrial, oil program and other public funds. Integrate high performance National Lab exploration capabilities to address difficult problems such as subsalt imaging, testing of advanced exploration concepts and multiphase flow in subsea pipelines. (\$6,481) (NL-TBD)</p>	<p>Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics and producibility from oil reservoirs, optimize the performance of production tools and processes, reduce environmental footprint and waste emissions and improve reservoir management resulting in higher oil recovery through leveraging of industrial, oil program and other public funds. Continue to integrate high performance National Lab computational capabilities to address difficult problems such as subsalt imaging, testing of advanced exploration concepts and multiphase flow in subsea pipelines. (\$7,416) (NL-TBD)</p>	<p>motor for coiled tubing drilling (\$1,898). (Total \$3,980) (Univ of Tulsa/LSU, WU, LLNL, ANL, Maurer, VA Polytech, PRRC, CalTech, CSM, Alabama, Hopi Tribe, Osage Tribe, TBD)</p> <p>Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics and producibility from oil reservoirs, optimize the performance of production tools and processes, reduce environmental footprint and waste emissions and improve reservoir management resulting in higher oil recovery through leveraging of industrial, oil program and other public funds. Continue to integrate high performance National Lab computational capabilities to address difficult problems such as subsalt imaging, testing of advanced exploration concepts and multiphase flow in subsea pipelines. (\$7,416) (NL-TBD)</p>

III. **Performance Summary**: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Exploration and Production Supporting Research (Cont'd)	Fund technical and program management support. (\$306)	Fund technical and program management support. (\$308)	Fund technical and program management support. (\$315)
	\$30,141	\$30,796	\$31,546
Recovery Field Demonstrations	Class 1-3 Revisit: Revisit major reservoir groups by competitively selecting cost-shared projects to extend reservoir life. Mid-Term: Complete funding of five competitively selected, cost-shared, field projects directed to demonstrating advanced reservoir description and extraction technologies that can result in substantial additional oil recovery in a significant number of Class 3 reservoirs. (\$5,150) (M&O, TBD)	Class 1-3 Revisit: Extend reservoir life to maximize oil recovery and improve environmental performance from our initial investment by revisiting major reservoir groups to address key production problems identified in previous work. (\$7,062) (TBD)	Class 1-3 Revisit: Extend reservoir life to maximize oil recovery and improve environmental performance from our initial investment by revisiting major reservoir groups to address key production problems identified in previous work. (\$6,622) (TBD)

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Recovery Field Demonstrations (Cont'd)	Increase Production from Marginal Wells: Increase production from marginal wells by conducting reservoir life extension projects such as: continue cost-shared reservoir management techniques for marginal wells (\$350). Continue cost-shared projects with small operators for innovative technologies to improve production efficiency and extend the life of in marginal wells at risk of abandonment (\$350). (Total \$700) (M&O, TBD)	Increase Production from Marginal Wells: Increase production from marginal wells by conducting reservoir life extension projects such as: continue cost-shared reservoir management techniques for marginal wells (\$330). Continue cost-shared projects with small operators for innovative technologies to improve production efficiency and extend the life of in marginal wells at risk of abandonment (\$330). (Total \$660) (TBD)	Increase Production from Marginal Wells: Review the promising technologies identified in the Class Program and Class Revisit projects to identify one technology and commence advanced research work on that technology. Focus on the technology transfer of the results. (\$100). Continue to focus on production problems identified by small operators by conducting cost-shared research with independents improved recovery or for reservoir management techniques on marginal wells at risk of abandonment. Improvement can come through decreased operating or environmental costs or improved equipment design (\$500). (Total \$600) (TBD)

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Recovery Field Demonstrations (Cont'd)	No activity. (\$0)	No activity. (\$0)	Preferred Petroleum Upstream Management Practices (PUMP): Supplement the Oil Technology program that will use the best currently available technology and employ a variety of proactive technology transfer mechanisms to get operators to implement them in the field; includes environmental problem solving to address key regional constraints, and data management efforts aimed at reducing costs for industry and government. (\$500) (TBD)
	Fund technical and program management support. (\$61)	Fund technical and program management support. (\$78)	Fund technical and program management support. (\$78)
	\$5,911	\$7,800	\$7,800

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Effective Environmental Protection	<p>Program Planning and Analysis: Continue analysis of industry and environmental trends and maintain performance measure data for program planning and technology transfer. Conduct cooperative efforts with industry, states, federal agencies and others to promote effective environmental protection and resolve regional environmental constraints to sustained oil production and efficient oil resource recovery. Perform legislative and regulatory impact analysis related to oil environmental issues. (\$800) (LBL, ANL, ICF, ALO, Hirsh, SPE, KGS, Terrane, IPEC, M&O, PERF, TBD)</p>	<p>Program Planning and Analysis: Continue analysis of industry environmental trends and maintain performance measure data for program planning and technology transfer. Continue to enhance cooperative efforts with industry, states, federal agencies and others to promote effective environmental protection and resolve regional environmental constraints to sustained oil production and efficient oil resource recovery. Coordinate with EPA and other Federal agencies to provide energy and economic analyses for longer term regulatory initiatives. Continue to perform legislative and regulatory impact analysis related to oil environmental issues. (\$825) (ANL, ICF, SPE/IPEC, ALO, Aspen Group, TBD)</p>	<p>Program Planning and Analysis: Continue analysis of industry environmental trends and available technologies. Maintain performance measure data for program planning and technology transfer. Continue coordination with states, EPA and other Federal agencies to provide energy and economic analyses for longer term regulatory initiatives. Continue to perform legislative and regulatory impact analysis related to oil environmental issues. (\$825) (ANL, ICF, PERF, SPCE, ALO, TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Effective Environmental Protection (Cont'd)	<p>Streamline State/Tribal/Federal Regulations: Continue a cooperative effort with the states, tribes, and Federal agencies to streamline environmental regulations and regulatory processes consistent with DNGOI objectives to simplify regulations without compromising environmental protection. Implement an on-line expert environmental and electronic reporting system to streamline permitting and to reduce costs to producers and regulators. (\$1,055) (IOGCC, M&O, EPA, BEG, TBD)</p>	<p>Streamline State/Tribal/Federal Regulations: Consistent with stakeholder needs, continue and enhance cooperative efforts with the states, tribes, and Federal agencies to streamline environmental regulations and regulatory processes to simplify regulations without compromising environmental protection. Enhance on-line expert environmental reporting and permitting systems to reduce costs to producers and regulators (\$1,500). (IOGCC, BEG, BNL, LLNL, Univ of Kentucky, WSPA, ORNL, Nat'l Labs, TBD)</p>	<p>Streamline State/Tribal/Federal Regulations: Consistent with stakeholder needs, continue and enhance cooperative efforts with the states, tribes, and Federal agencies to streamline environmental regulations and regulatory processes to simplify regulations without compromising environmental protection. Enhance on-line expert environmental reporting and permitting systems to reduce costs to producers and regulators (\$800). Generate independent quality scientific data to help implement national policy in streamlining and improving existing regulations and laws (\$776). (Total \$1,576) (IOGCC, ORNL, WSPA, Nat'l Labs, TBD)</p>

III. Performance Summary: OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Effective Environmental Protection (Cont'd)	<p>Risk Assessment: Continue research to assess and mitigate environmental risks posed by oil exploration and production including risks posed by injection for disposal and enhanced oil recovery, hydrocarbon or produced water spills, air emissions from exploration and production facilities, and management of oil field wastes. Continue assistance to States with research, analysis, and improved data management to support risk-based regulatory decisions, consistent with the objectives of streamlining and improving environmental regulations. Provide credible scientific data for decision-making. (\$3,344) (GWPC, LLNL, TBD, Osage, NL-TBD ,BNL, LBL, BLM, INEEL, Louisiana, M&O)</p>	<p>Risk Assessment: Continue to provide credible scientific data for regulatory decision making. Continue cooperative efforts with regulatory and industry groups to establish environmentally acceptable end-points. Continue research to assess and mitigate environmental risks posed by exploration and production, including risks posed by injection for disposal and enhanced oil recovery, hydrocarbon or produced water spills, air emissions and management of oil field wastes. Continue support for development of compatible data management systems between state and Federal agencies. Continue assistance to States with research, analysis, and improved data management to support risk-based regulatory decisions consistent with stakeholder's objectives of streamlining and improving environmental regulations (\$2,760). Work with industry, states, and</p>	<p>Risk Assessment: Continue to provide credible scientific data for regulatory decision making. Continue research to assess and mitigate environmental risks posed by exploration and production, including risks posed by injection for disposal and enhanced oil recovery, hydrocarbon or produced water spills, air emissions and management of oil field wastes. Continue assistance to States with research, analysis, and improved data management to support risk-based regulatory decisions consistent with stakeholder's objectives of streamlining and improving environmental regulations (\$3,260). Work with industry, states, and EPA to conduct research to help EPA make decisions based on sound science in the area of particulate matter emissions. Serve as a neutral third party between</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Effective Environmental Protection (Cont'd)		<p>Work with industry, states, and EPA to conduct research to help EPA make decisions based on sound science in the area of particulate matter emissions. Serve as a neutral third party between Federal and state regulators and the petroleum industry to develop scientific information on the environmental and health risks of pollutants emitted by the petroleum industry (\$1,500). (Total \$4,260) (GWPC, IGT, WSPA, PERF, ANL, INEEL BNL, LBL, ORNL, SNL, Nat'l Labs, RMC, Aspen Group, Osage, TBD)</p>	<p>Federal and state regulators and the petroleum industry to develop scientific information on the environmental and health risks of pollutants emitted by the petroleum industry (\$1,627). (Total \$4,887) (GWPC, Natl. Labs, BNL, INEEL, IOGCC, ANL, BLM, PERF, TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Effective Environmental Protection (Cont'd)	<p>Technology Development: Continue research to develop and field test more cost-effective environmental compliance technologies in the areas of produced water treatment, soil remediation, air emissions control, and oil field waste management. (\$962) (ONRL, PNL, TBD, U of Tulsa, M&O)</p>	<p>Technology Development: Continue to develop and field test more cost-effective environmental compliance technologies in the areas of produced water treatment, remediation, air emissions control and monitoring, and oil field waste management and disposal. Identify various pollutants present in petroleum and develop technology to prevent their formation. In keeping with PCAST recommendations, perform research to make fuels that have fewer emissions affecting global climate change. (Total \$3,335) (TBD, Natl Labs, ANL, ORNL, INEEL, BNL, PNL, TU, OERB)</p>	<p>Technology Development: Continue to develop and field test more cost-effective environmental compliance technologies in the areas of produced water treatment, remediation, air emissions control and monitoring, and oil field waste management and disposal (\$1,451). Identify various pollutants present in petroleum and develop technology to prevent their formation. In keeping with PCAST recommendations, perform research to make fuels that have fewer emissions affecting global climate change (\$1,973). (Total \$3,424) (TBD, Natl Labs, ORNL, INEEL, PNL, OERB, Univ of Tulsa)</p>
	<p>Fund technical and program management support (\$63).</p>	<p>Fund technical and program management support. (\$100)</p>	<p>Fund technical and program management support. (\$108)</p>
	\$6,224	\$10,020	\$10,820

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Emerging Processing Technology Applications	<p>Pollution Prevention: Continue to obtain thermo-dynamic, chemical, and physical data on heavy crude oil and residue components, improve upgrading, and overcome environmental barriers, especially on West Coast heavy oils. Continue to research cracking and coking phenomena to improve upgrading and refining efficiencies and increase yields of transportation fuels in an environmentally efficient manner. Continue to provide fundamental science, accepted by all parties, to support development of efficient environmental regulations that progress beyond command and control. Work will also be conducted to identify various pollutants and technology will be developed to prevent their formation. (\$3,890) (ORNL, LBL, BNL, INEEL, ANL, SNL, PNL, NREL, EER, Orange/Rockland, Air/Waste Mgmt, SWPA, M&O, Nat. Lab, TBD)</p>	<p>The majority of this subprogram has been combined with Effective Environmental Protection above. The process thermodynamics/chemistry portion of the subprogram has been discontinued because of uncertainty about its value to the nation and the appropriate Federal role in this effort. (\$0)</p>	<p>No activity. (\$0)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Emerging Processing Technology Applications (Cont'd)	Science for Environmental Protection: Continue to provide fundamental science to assist the petroleum industry to improve environmental protection, and change crude oil, product specifications and quality to meet environmental constraints. Studies will be concerned with environmental chemistry and physics associated with remediation, wastewater treatment, waste disposal and air emissions. Work will be coordinated and performed with the regulators and industrial organizations to expedite implementation of pollution prevention processes in the refineries. Many of these programs are to support goals consistent with DNGOI 6.3 and 6.5 in support of a beneficial and viable U.S. refining industry. (\$947) (M&O, PERF, LBL, ORNL, Natl Labs)	The majority of this subprogram has been combined with Effective Environmental Protection above. The process thermodynamics/chemistry portion of the subprogram has been discontinued because of uncertainty about its value to the nation and the appropriate Federal role in this effort. (\$0)	No activity. (\$0)

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Emerging Processing Technology Applications (Cont'd)	<p>Upgrading Research: Continue to study fundamental chemistry and physics thru cooperative research programs with the national laboratories and industrial groups in support of the above overall environmental efforts in upgrading very heavy crude oil before it is refined. Emphasis will be placed on biotechnology to remove S, N and heavy metals from crude oil. (\$540) (ANL, ORNL, M&O, INEEL)</p> <p>Fund technical and program management support. (\$55)</p>	<p>The majority of this subprogram has been combined with Effective Environmental Protection above. The process thermodynamics/chemistry portion of the subprogram has been discontinued because of uncertainty about its value to the nation and the appropriate Federal role in this effort. (\$0)</p> <p>No activity. (\$0)</p>	<p>No activity. (\$0)</p> <p>No activity. (\$0)</p>
	\$5,432	\$0	\$0
Oil Technology, Total	\$47,708	\$48,616	\$50,166

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PROGRAM DIRECTION AND MANAGEMENT SUPPORT

I. Mission Supporting Goals and Objectives:

This activity provides funding for salaries, benefits and overhead expenses for management of the Fossil Energy program at Headquarters, the Federal Energy Technology Center, and the National Petroleum Technology Office. The Headquarters staff is responsible for overall direction of the programs that include implementing DOE policy, communicating guidance consistent with that policy to the FE field offices, establishing program objectives, developing program plans and evaluating alternative program strategies, developing and defending budget requests to the Office of Management and Budget and to Congress, reviewing procurement plans, monitoring work progress, and approving revisions in work plans as required to attain program goals. The Federal Energy Technology Center and project office perform the day-to-day project management functions of assigned programmatic areas that include monitoring Fossil Energy contracts and National Laboratory activities, developing project budgets, implementing procurement plans, and other program and site support activities necessary to achieve program objectives.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Headquarters Program Direction					
Salaries and Benefits	\$9,240	\$9,282	\$9,662	\$380	4%
Travel	450	420	489	69	16%
Contract Services	<u>4,969</u>	<u>5,347</u>	<u>5,865</u>	<u>518</u>	<u>10%</u>
Subtotal, Headquarters Program Direction	14,659	15,049	16,016	967	6%

II.A. **Funding Schedule:** PROGRAM DIRECTION AND MANAGEMENT SUPPORT

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Field Program Direction					
Salaries and Benefits	25,674	27,830	29,152	1,322	5%
Travel	1,425	1,344	1,398	54	4%
Contract Services	<u>25,072</u>	<u>25,258</u>	<u>25,513</u>	<u>255</u>	<u>1%</u>
Subtotal, Field Program Direction	<u>52,171</u>	<u>54,432</u>	<u>56,063</u>	<u>1,631</u>	<u>3%</u>
Total, Program Direction and Management Support	<u>\$66,830</u>	<u>\$69,481</u>	<u>\$72,079</u>	<u>\$2,598</u>	<u>4%</u>

II. B. **Laboratory and Facility Funding Schedule:** PROGRAM DIRECTION AND MANAGEMENT SUPPORT

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
National Petroleum Technology Office	\$3,437	\$3,782	\$4,161	\$379	10%
Federal Energy Technology Center	48,734	50,650	51,902	1,252	2%
All Other	<u>14,659</u>	<u>15,049</u>	<u>16,016</u>	<u>967</u>	<u>6%</u>
Total, Program Direction and Management Support	<u>\$66,830</u>	<u>\$69,481</u>	<u>\$72,079</u>	<u>\$2,598</u>	<u>4%</u>

III. Performance Summary: PROGRAM DIRECTION AND MANAGEMENT SUPPORT

Activity	FY 1998	FY 1999	FY 2000
Headquarters Program Direction - Salaries and Benefits	Provide funds for 97 FTEs at Headquarters. This staff implements and communicates policy to the FETC, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans; and monitors work progress. (\$9,240)	Provide funds for 97 FTE's at Headquarters. This staff implements and communicates policy to the ETC's, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans; and monitors work progress. (\$9,282)	Provide funds for 97 FTE's at Headquarters. This staff implements and communicates policy to the ETC's, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans; and monitors work progress. (\$9,662)
	\$9,240	\$9,282	\$9,662
Travel	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. (\$450)	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. (\$420)	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. (\$489)
	\$450	\$420	\$489
Headquarters Program Direction - Contract Services	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services (\$998). Provide for E-mail and LAN requirements (\$348). (Total \$1,346) (TBD)	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services (\$1,000). Provide for E-mail and LAN requirements (\$350). (Total \$1,350) (TBD)	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services (\$1,200). Provide for E-mail and LAN requirements (\$550). (Total \$1,750) (TBD)

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Headquarters Program Direction (Cont'd) - Contract Services	Fund SBIR in the amount of \$6,036 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund SBIR in the amount of \$6,607 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund SBIR in the amount of \$7,017 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)
	Fund the Small Business Technology Transfer (STTR) in the amount of \$362 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund the Small Business Technology Transfer (STTR) in the amount of \$398 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund the Small Business Technology Transfer (STTR) in the amount of \$451 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)
	Fund AD for direct support of computer timesharing/housekeeping (\$199). Fund AD for workstation support for LAN (\$199). (Total \$398)	Fund AD for direct support of computer timesharing/housekeeping (\$235). Fund AD for workstation support for LAN (\$200). (Total \$435)	Fund AD for direct support of computer timesharing/housekeeping (\$285). Fund AD for workstation support for LAN (\$200). (Total \$485)
	Provide for printing services. (\$130) (TIC)	Provide for printing services. (\$30) (TIC)	Provide for printing services. (\$80) (TIC)
	No activity. (\$0)	Upgrade electronic records management systems. (\$100)	Upgrade electronic records management systems. (\$100)
	Provide working capital fund. (\$3,095)	Provide working capital fund. (\$3,432)	Provide working capital fund. (\$3,450)
	\$4,969	\$5,347	\$5,865

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Headquarters Program Direction, Subtotal	\$14,659	\$15,049	\$16,016
ETC Program Direction Salaries and Benefits	Provide funds for FETC and NPTO indirect staff of 312 (FETC - 287; NPTO - 25) FTEs. Activities of the staff include contract and lab monitoring, development and maintenance of project, budget and procurement plans, and other activities related to program and site support (FETC - \$24,000, NPTO - \$1,674) (Total \$25,674)	Provide funds for FETC and NPTO indirect staff of 311 (FETC - 288; NPTO - 23) FTEs. Activities of the staff include contract and lab monitoring, development and maintenance of project, budget and procurement plans, and other activities related to program and site support (FETC - \$25,520, NPTO - \$2,310) (Total \$27,830)	Provide funds for FETC and NPTO indirect staff of 315 (FETC - 288; NPTO - 27) FTEs. Activities of the staff include contract and lab monitoring, development and maintenance of project, budget and procurement plans, and other activities related to program and site support (FETC - \$26,632, NPTO - \$2,520) (Total \$29,152)
	\$25,674	\$27,830	\$29,152
Travel	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (FETC - \$1,203, NPTO - \$222) (Total \$1,425)	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (FETC - \$1,083, NPTO - \$261) (Total \$1,344)	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (FETC - \$1,137, NPTO - \$261) (Total \$1,398)
	\$1,425	\$1,344	\$1,398

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Contract Services	Provide substantial funding of facility operations, maintenance, finance, AOSS support, administrative, management and technical support. (FETC - \$23,531, NPTO - \$1,541) (Total \$25,072)	Provide substantial funding of facility operations, maintenance, finance, AOSS support, administrative, management and technical support. (FETC - \$24,047, NPTO - \$1,211) (Total \$25,258)	Provide substantial funding of facility operations, maintenance, finance, AOSS support, administrative, management and technical support. (FETC - \$24,133, NPTO - \$1,380) (Total \$25,513)
	\$25,072	\$25,258	\$25,513
Field Program Direction, Subtotal	\$52,171	\$54,432	\$56,063
Program Direction and Management Support, Total	\$66,830	\$69,481	\$72,079

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PLANT AND CAPITAL EQUIPMENT

I. Mission Supporting Goals and Objectives:

No funding is requested for capital equipment purchases. Any such needs will be funded within project operating costs, subject to Congressional reprogramming guidelines.

Funding for general plant projects at the Federal Energy Technology Center (FETC) sites and at the National Petroleum Technology Office (NPTO) is requested. General plant projects include repairs, improvements, alterations and additions that are essential to the safe, environmentally acceptable and efficient operations of the FETC sites and NPTO.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Construction	\$2,532	\$2,600	\$2,000	\$-600	-23%
Total, Plant and Capital Equipment	<u>\$2,532</u>	<u>\$2,600</u>	<u>\$2,000</u>	<u>\$-600</u>	<u>-23%</u>

II. B. Laboratory and Facility Funding Schedule

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
All Other	\$2,532	\$2,600	\$2,000	\$-600	-23%
Total, Plant and Capital Equipment	<u>\$2,532</u>	<u>\$2,600</u>	<u>\$2,000</u>	<u>\$-600</u>	<u>-23%</u>

III. **Performance Summary**: PLANT AND CAPITAL EQUIPMENT

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Construction	Provide General Plant Projects (GPP) at the FETC and NPTO. (\$2,532)	Provide for General Plant Projects (GPP) at the FETC and NPTO. (\$2,600)	Provide for General Plant Projects (GPP) at the FETC and NPTO. (\$2,000)
	\$2,532	\$2,600	\$2,000
Plant and Capital Equipment, Total	\$2,532	\$2,600	\$2,000

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

FOSSIL ENERGY ENVIRONMENTAL RESTORATION

I. Mission Supporting Goals and Objectives:

The objectives of the Fossil Energy (FE) Environmental Restoration activities are to ensure protection of workers, the public, and the environment in performing the mission of the Federal Energy Technology Center (FETC) at Morgantown (MGN), West Virginia and Pittsburgh (PGH), Pennsylvania sites, the National Petroleum Technology Office (NPTO) in Tulsa, Oklahoma, and the Albany Research Center (ARC) in Albany, Oregon. Activities include those necessary to protect workers and the public from exposure to hazardous conditions and materials (e.g., fires, carcinogens, asbestos, lead, etc.) and to achieve compliance with Federal, state and local safety and health requirements. Activities also include environmental protection, and cleanup activities on-site, and at several former off-site research and development locations. In previous years, DOE received a Notice of Violation from the State of Wyoming requiring cleanup of the Rock Springs and Hoe Creek sites. Recent Occupational Safety and Health Administration (OSHA) inspections of the ARC site have resulted in the issuance of Notices of Unsafe or Unhealthful Working Conditions as well as Notification of Failure to Abate Alleged Violations which identified safety and health hazards. Groundwater and soil monitoring/remediation is also required at the FETC and ARC sites to ensure compliance with Federal, state and local requirements.

FY 2000 performance measures are listed below that support the overarching goal of making consistent and measurable progress in reducing and eliminating injuries, incidents and environmental releases.

- Asbestos, lead, mercury and PCB site surveys completed at Albany Research Center (ARC).
- Seven major lead and asbestos abatements completed at the Federal Energy Technology Center (FETC). Life safety code deficiencies eliminated at 3 FETC buildings.
- Groundwater cleanup demonstrations completed and remedial actions developed for FETC CERCLA sites in Wyoming.
- Industrial hygiene/safety program implemented at ARC.
- Fired alarm systems installed, toxic gas monitoring systems upgraded, drinking water lines replaced, and ventilation deficiencies eliminated at FETC.

II. A. **Funding Schedule:** FOSSIL ENERGY ENVIRONMENTAL RESTORATION (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
CERCLA Remedial Actions	\$4,119	\$3,525	\$2,122	\$-1,403	-40%
RCRA Remedial Actions	4,923	2,423	2,345	-78	-3%
Other ES&H Actions	<u>3,893</u>	<u>5,052</u>	5,533	<u>481</u>	<u>10%</u>
Total, Fossil Energy Environmental Restoration	<u>\$12,935</u>	<u>\$11,000</u>	<u>\$10,000</u>	<u>\$-1,000</u>	<u>-9%</u>

II. B. **Laboratory and Facility Funding Schedule:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$12,935</u>	<u>\$11,000</u>	<u>\$10,000</u>	<u>\$-1,000</u>	<u>-9%</u>
Total, Fossil Energy Environmental Restoration	<u>\$12,935</u>	<u>\$11,000</u>	<u>\$10,000</u>	<u>\$-1,000</u>	<u>-9%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
CERCLA Remedial Actions	Continue cleanup of Rock Springs sites. (\$634) (Army Corp of Engineers)	Continue cleanup of Rock Springs sites. (\$750) (Army Corps of Engineers)	Continue cleanup of Rock Springs sites. (\$952) (Army Corps of Engineers)
	Continue cleanup of Hoe Creek site. (\$959) (TBD)	Continue cleanup of Hoe Creek site. (\$800) (Army Corps of Engineers)	Continue cleanup of Hoe Creek site. (\$835) (Army Corps of Engineers)
	Initiate Hannah Site revegetation. (\$22)	Continue Hannah Site revegetation. (\$50)	Continue Hannah Site revegetation. (\$35)

III. Performance Summary: FOSSIL ENERGY ENVIRONMENTAL RESTORATION

Activity	FY 1998	FY 1999	FY 2000
CERCLA Remedial Actions (Cont'd)	Perform preliminary assessment/site investigations of inactive projects. (\$247)	Continue preliminary assessment/site investigations of FETC inactive projects. (\$425)	No activity. (\$0)
	No activity. (\$0)	Continue with Phase II FETC risk assessment documentation. (\$60)	No activity. (\$0)
	Continue cleanup of soil and groundwater at former FETC liquefaction sites. (\$2,061) (TBD)	Continue cleanup of soil and groundwater at former FETC liquefaction sites. (\$530) (TBD)	No activity. (\$0)
	Complete Magnetohydrodynamics (MHD) closeout and cleanup ES&H actions. (\$103) (TBD)	No activity. (\$0)	No activity. (\$0)
	No activity. (\$0)	Perform onsite CERCLA-type remediation assessments at FETC. (\$50) (TBD)	Perform onsite CERCLA-type remediation assessments at FETC. (\$100) (TBD)
	Fund Western Processing remediation activities. (\$93) (TBD)	Implement CERCLA PRP Response Activities (e.g. Western Processing). (\$860) (TBD)	Implement CERCLA PRP Response Activities (\$200) (TBD)
	\$4,119	\$3,525	\$2,122

III. Performance Summary: FOSSIL ENERGY ENVIRONMENTAL RESTORATION

Activity	FY 1998	FY 1999	FY 2000
RCRA Remedial Actions	<p>Continue FETC on-site remediation activities such as acid mine drainage; stormwater line consolidation; contaminated sewer line and abandoned pipeline removal; lead and asbestos abatement; PCB removal; develop toxic chemical management system; waste minimization/pollution prevention; characterizing hazardous wastes; reducing hazardous waste generation; monitoring groundwater and air quality; implementing ozone protection program; and updating site RCRA requirements. (\$2,458) (TBD)</p> <p>Complete remediation actions to close NIPER. (\$2,465) (TBD)</p>	<p>Continue FETC on-site remediation activities such as lead and asbestos abatement; underdrain leachate remediation; waste minimization and pollution prevention activities; toxic chemical management program upgrades; hazardous material and waste compliance activities; PCB removal; resolution of fecal coliform in stormwater; improvements in stormwater catch basin; replacement of ozone depleting substances; and closeout of inactive waste ponds. (\$1,723) (TBD)</p> <p>No activity. (\$0)</p>	<p>Continue FETC on-site remediation activities such as lead and asbestos abatement; waste minimization and pollution prevention activities; toxic chemical management program upgrades; hazardous material and waste compliance activities; and surface water compliance problems. (\$1,400) (TBD)</p> <p>No activity. (\$0)</p>

III. Performance Summary: FOSSIL ENERGY ENVIRONMENTAL RESTORATION

Activity	FY 1998	FY 1999	FY 2000
RCRA Remedial Actions (Cont'd)	No activity. (\$0)	Initiate RCRA cleanup actions at Albany Research Center including characterizing and resolving chemical and radioactive storage, labeling; handling; and disposal problems. (\$700) (TBD)	Continue RCRA cleanup actions at Albany Research Center including characterizing and resolving chemical and radioactive storage and labeling; soil and groundwater characterization; fume hood and scrubber upgrades; air emission management; and materials handling and disposal problems. (\$945) (TBD)
	\$4,923	\$2,423	\$2,345
Other ES&H Actions	Continue ES&H activities at the FETC sites requiring corrective action and related activities. (\$3,764) (IITRI, TBD)	Continue ES&H activities at the FETC sites requiring corrective action and related activities including monitoring and surveillance; indoor air quality fixes; resolution of life safety code deficiencies; fire protection compliance actions; ergonomics; training improvements; structural safety fixes; and emergency preparedness upgrades. (\$4,446) (TBD)	Continue ES&H activities at the FETC sites requiring corrective action and related activities including monitoring and surveillance; indoor air quality fixes; resolution of life safety code deficiencies; fire protection compliance actions; ergonomics; training improvements; structural safety fixes; and emergency preparedness upgrades. (\$4,296) (TBD)

III. **Performance Summary**: FOSSIL ENERGY ENVIRONMENTAL RESTORATION

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Other ES&H Actions (Cont'd)	No activity. (\$0)	No activity. (\$0)	Initiate ES&H program activities at NPTO including emergency management and drills, training, etc. (\$20) (TBD)
	No activity. (\$0)	Initiate site-wide safety and health corrective actions at Albany Research Center including training, machine guarding, lockout/tagout, and fume hoods. (\$496) (TBD)	Initiate site-wide safety and health corrective actions at Albany Research Center including structural upgrading; monitoring and surveillance; indoor air quality and ventilation upgrades; fire suppression systems; and training. (\$1,107) (TBD)
	Technical and management support. (\$129)	Technical and management support. (\$110)	Technical and management support. (\$110)
	\$3,893	\$5,052	\$5,533
Fossil Energy Environmental Restoration, Total	\$12,935	\$11,000	\$10,000

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

COOPERATIVE RESEARCH AND DEVELOPMENT

I. Mission Supporting Goals and Objectives:

The Cooperative Research and Development program addresses national priority objectives by supporting strategic Fossil Energy research of high merit and relevance to the U.S. market that is selected and funded collaboratively by federal and non-federal parties. It currently supports activities of federal/industry/research institute endeavors and federal/state/industry partnerships. It was originally created in FY 1989 and provided the federal share of support for Jointly Sponsored Research Programs (JSRP) at the Western Research Institute (WRI) and the University of North Dakota Energy and Environmental Research Center (UNDEERC). The research projects under the JSRP at those centers receive at least 50 percent cost sharing from non-federal partners.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Cooperative Research and Development	<u>\$5,686</u>	<u>\$6,836</u>	<u>\$5,836</u>	<u>\$-1,000</u>	<u>0%</u>
Total, Cooperative Research and Development	<u>\$5,686</u>	<u>\$6,836</u>	<u>\$5,836</u>	<u>\$-1,000</u>	<u>0%</u>

II. B. Laboratory and Facility Funding Schedule:

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$5,686</u>	<u>\$6,836</u>	<u>\$5,836</u>	<u>\$-1,000</u>	<u>0%</u>
Total, Cooperative Research and Development	<u>\$5,686</u>	<u>\$6,836</u>	<u>\$5,836</u>	<u>\$-1,000</u>	<u>0%</u>

III. **Performance Summary**: COOPERATIVE RESEARCH AND DEVELOPMENT (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Cooperative Research and Development	Provide support for cooperative research programs at WRI (\$2,823) and UNDEERC (\$2,823) which are 50-50 cost-shared with non-federal clients. (\$5,646) (WRI, UNDEERC)	Provide support for cooperative research programs at WRI (\$3,398) and UNDEERC (\$3,398) which are 50-50 cost-shared with non-federal clients. (\$6,796) (WRI, UNDEERC)	Provide support for cooperative research programs at WRI (\$2,898) and UNDEERC (\$2,898) which are 50-50 cost-shared with non-federal clients. (\$5,796) (WRI, UNDEERC)
	Fund technical and program management support. (\$40)	Fund technical and program management support. (\$40)	Fund technical and program management support. (\$40)
Cooperative Research and Development, Total	\$5,686	\$6,836	\$5,836

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

FUELS PROGRAM

I. Mission Supporting Goals and Objectives:

The Office of Fuels Programs (OFP) manages the regulatory review of natural gas imports and exports, exports of electricity, and the construction and operation of electric transmission lines which cross U.S. international borders; and exercises regulatory oversight of the conversion of existing oil and gas-fired powerplants, processes exemptions from the statutory provisions of the Powerplant and Industrial Fuel Use Act of 1978 (FUA), as amended, and processes certifications of alternate fuel capability pursuant to the provisions of the amended FUA. These regulatory activities help promote the national energy strategy goal of securing future energy supplies by helping to ensure: the availability of reliable, competitively priced natural gas; that surplus domestic gas supplies can be marketed internationally in a competitive and environmentally sound manner; and that exports of electric energy and the construction of new international electric transmission lines do not adversely impact on the reliability of the U.S. electric power supply system. The program promotes the use of alternate fuels in new baseload electric powerplants; and assumes that international gas and electricity trade occurs in the freest possible marketplace. The OFP's activities help deregulate energy markets and reduce international trade barriers, and to create an integrated North American energy market. OFP encourages greater exchange of technical and regulatory information among our trading partners. Through its publications, OFP increases public awareness of energy issues and the advantages of competition in the marketplace.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Fuels Program	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$0</u>	<u>0%</u>
Total, Fuels Program	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$0</u>	<u>0%</u>

II. B. **Laboratory and Facility Funding Schedule:** FUELS PROGRAM (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$0</u>	<u>0%</u>
Total, Fuels Program	<u>\$2,188</u>	<u>\$2,173</u>	<u>\$2,173</u>	<u>\$0</u>	<u>0%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Fuels Program	<p>Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. (\$50)</p> <p>Process 200 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Participate in FERC proceedings and international studies. Provide petroleum policy support for ASFE. NEPA compliance activities. (19 FTEs) (\$1,357)</p>	<p>Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. (\$50)</p> <p>Process 200 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Participate in FERC proceedings and international studies. Provide petroleum policy support for ASFE. NEPA compliance activities. (19 FTEs) (\$1,357)</p>	<p>Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. (\$50)</p> <p>Process 200 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Participate in FERC proceedings and international studies. Provide petroleum policy support for ASFE. NEPA compliance activities. (19 FTEs) (\$1,357)</p>

III. **Performance Summary**: FUELS PROGRAM (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
Fuels Program (Cont'd)	Process 35 electricity export applications and 10 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. (\$630)	Process 75 electricity export applications and 10 new construction permits. Amend 110 existing permits to required open access. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. (\$630)	Process 100 electricity export applications and 10 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. (\$630)
	Provide management and administrative support. (\$136)	Provide management and administrative support. (\$136)	Provide management and administrative support. (\$136)
Fuels Program, Total	\$2,173	\$2,173	\$2,173

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

ADVANCED METALLURGICAL PROCESSES

I. Mission Supporting Goals and Objectives:

The following mission was transferred from the Bureau of Mines to the Department of Energy in Public Law 104-99 in FY 1996 and currently remains in the DOE:

- The conduct of inquiries, technological investigations, research concerning the extraction, processing, use, and disposal of mineral substances under the mineral and materials science program at the Albany Research Center (ARC) in Oregon.

The mission of the materials program at the Albany Research Center (ARC) incorporates Advanced Metallurgical Processes that provide essential life-cycle information for evaluation of materials. The program addresses the full life cycle of materials production and cost-effective processing of improved materials through their disposal and recycling. The program seeks to determine the factors that limit service life of materials in industrial, structural, or engineering applications and to provide solutions to service-life problems through new materials technology, to develop and demonstrate technologies that will reduce waste and pollution, and to use capabilities and expertise to provide focused solutions to high priority national problems. The research at ARC directly contributes to Fossil Energy's objectives by providing information on the performance characteristics of materials being specified for the current generation of power systems, on the development of cost-effective materials for inclusion in Vision 21 systems, and for solving environmental emission problems related to fossil fired energy systems. The program at ARC stresses full participation with industry through partnerships and emphasizes cost sharing to the fullest extent possible.

Performance Measures:

The Advanced Metallurgical Processes program directly contributes to Fossil Energy's objectives by providing information on the performance characteristics of materials being specified for advanced power generation systems, on the development of cost-effective materials for inclusion in Vision 21 systems, and for solving environmental emission problems related to fossil energy systems.

I. **Mission Supporting Goals and Objectives:** ADVANCED METALLURGICAL PROCESSES (Cont'd)

Activities in FY 2000 that contribute to this ultimate goal include:

- Initiate research efforts to determine alternate sources and processes for magnesium and calcium as potential feedstock for the mineral carbonation approach for permanent CO₂ sequestration.
- Complete initial phase of joint (IGCC/Advanced Research/Advanced Metallurgical Processes) project initiated during FY 1999, and begin second phase of study to test and improve the performance of commercially available refractories for IGCC applications.
- Complete successful demonstration of pilot scale (~1,000 lb/hr) vitrification of multiple powerplant waste streams. Generate sufficient material for utilization in end use studies and sufficient data for a realistic economic cost evaluation, and a validated process.
- Develop a continuous casting process for lightweight titanium for gas and oil industry applications.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
Advanced Metallurgical Processes	<u>\$4,965</u>	<u>\$5,000</u>	<u>\$5,000</u>	<u>\$0</u>	<u>0%</u>
Total, Advanced Metallurgical Processes	<u>\$4,965</u>	<u>\$5,000</u>	<u>\$5,000</u>	<u>\$0</u>	<u>0%</u>

II. B. **Laboratory and Facility Funding Schedule**

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$4,965</u>	<u>\$5,000</u>	<u>\$5,000</u>	<u>\$0</u>	<u>0%</u>
Total, Advanced Metallurgical Processes	<u>\$4,965</u>	<u>\$5,000</u>	<u>\$5,000</u>	<u>\$0</u>	<u>0%</u>

III. **Performance Summary**: ADVANCED METALLURGICAL PROCESSES (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Metallurgical Processes	Continue research focused on conservation of natural resources through extending the service life of materials or finding substitute materials and processing paths for those that are environmentally hazardous. Continue research efforts in partnership with industry and with State and Federal agencies to build viable domestic commercial capabilities in waste-free, environmentally benign metal alloy production, joining, and forming. Continue research related to corrosion of infrastructure and efforts to achieve better understanding of wear, corrosion, and fracture, resulting in an improved understanding of materials structure and properties for better performance. Develop a continuous casting process for lightweight titanium. Begin	Initiate research identified during FY 1998 to contribute to Fossil Energy's Vision 21 Systems to include reducing greenhouse gas emissions through CO ₂ sequestration, advanced refractory research, and partnerships for implementing improved efficiency technology, energy production system by-product processing and materials development. Continue research efforts in partnership with industry and with State and Federal agencies to build viable domestic commercial capabilities in waste-free environmentally benign materials production. Continue research efforts to achieve better understanding of wear, corrosion, and fracture, resulting in an improved understanding of component structure and properties for better performance in mining and	Continue research identified during FY 1999 to contribute to Fossil Energy's Vision 21 Systems to include reducing greenhouse gas emissions through CO ₂ sequestration, advanced refractory research, and partnerships for implementing improved efficiency technology, energy production system by-product processing and materials development. Continue research efforts in partnership with industry and with State and Federal agencies to build viable domestic commercial capabilities in waste-free environmentally benign materials production. Continue research efforts to achieve better understanding of wear, corrosion, and fracture, resulting in an improved understanding of component structure and properties for better performance

III. **Performance Summary**: ADVANCED METALLURGICAL PROCESSES (Cont'd)

<u>Activity</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
Advanced Metallurgical Processes (Cont'd)	crosscut research identified during FY 1996 to complement Fossil Energy R&D objectives. (\$4,915) (ARC)	processing of coal and in Vision 21 System components. Develop a continuous casting process for lightweight titanium for gas and oil industry applications. (\$4,950) (ARC)	in mining and processing of coal and in Vision 21 System components. Develop a continuous casting process for lightweight titanium for gas and oil industry applications. (\$4,950) (ARC)
	Fund technical and program management support. (\$50)	Fund technical and program management support. (\$50)	Fund technical and program management support. (\$50)
	\$4,965	\$5,000	\$5,000
Advanced Metallurgical Processes, Total	\$4,965	\$5,000	\$5,000

**Climate Change Technology Initiative (CCTI)
Departmental Crosscut**

(dollars in thousands)

	FY 1998 Actual	FY 1999 Enacted	FY 2000 Request	\$ Change	% Change
Energy & Water Development					
Energy Supply:					
Solar and Renewable	\$269,904	\$336,000	\$398,921	\$62,921	18.7%
Nuclear Energy	0	0	5,000	5,000	100.0%
Subtotal, Energy Supply	269,904	336,000	403,921	67,921	20.2%
Science	0	13,500	33,000	19,500	144.4%
Subtotal, Science	0	13,500	33,000	19,500	144.4%
Subtotal, Energy & Water	269,904	349,500	436,921	87,421	25.0%
Interior and Related Agencies					
Energy Conservation R&D	450,215	525,701	646,515	120,814	23.0%
Fossil Energy R&D	0	23,890	36,776	12,886	53.9%
Energy Information Administration	0	2,500	3,000	500	20.0%
Subtotal, Interior and Related Agencies	450,215	552,091	686,291	134,200	24.3%
Total, DOE	\$720,119	\$901,591	\$1,123,212	\$221,621	24.6%

OFFICE OF FOSSIL ENERGY
Climate Change Funding

(\$ in Thousands)

	<u>FY 1999</u>	<u>FY 2000</u>
	<u>Appropriation</u>	<u>Request</u>
COAL		
Advanced Clean/Efficient Power Systems		
Indirect Fired Cycle	\$1,000	\$1,000
High Efficiency - Integrated Gasification Combined Cycle	\$14,000	\$16,250
High Efficiency - Pressurized Fluidized Bed		
Gas Stream Cleanup	0	\$1,000
Pressurized Fluidized Bed Combustion	0	\$400
Vision 21	0	\$200
Advanced Research and Environmental Technology		
CO ₂ Control/Sequestration	\$5,890	\$9,126
Advanced Research and Technology Development		
Coal Utilization Science	\$2,000	\$2,000
Materials & Components	\$1,000	\$1,000
GAS		
Natural Gas Research		
Turbines		
Vision 21	0	\$800
Fuel Cells	<u>0</u>	<u>\$5,000</u>
TOTAL	<u><u>\$23,890</u></u>	<u><u>\$36,776</u></u>

**DOE NATURAL GAS R&D ACTIVITIES
PROGRAM CROSSCUTTING BUDGET**

Natural Gas Program Sectors	GRI 1999	Department-Wide			Fossil Energy			Energy Efficiency			Science Research		
		FY 98	FY 99	FY 2000 Cong. Request	FY98	FY99	FY 2000 Cong. Request	FY98	FY99	FY 2000 Cong. Request	FY98	FY99	FY 2000 Cong. Request
Exploration and Production	28.2	21.6	19.9	18.6	13.6	13.4	14.9	-	-	-	8.0	6.5	3.7
Delivery and Storage	26.7	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-
Utilization	33.0	179.9	211.7	197.0	90.7	97.7	86.6	84.9	110.2	106.8	4.3	3.8	3.6
Combustion Systems	10.5	5.7	7.4	5.6	-	-	-	1.6	3.6	2.0	4.1	3.8	3.6
Buildings - Heating & Cooling	10.6	8.7	10.8	9.6	-	-	-	8.7	10.8	9.6	-	-	-
Gas Turbines	1.1	82.8	95.5	76.8	43.9	44.5	41.8	38.9	51.0	35.0	-	-	-
Natural Gas Vehicles	2.8	16.2	17.2	22.0	-	-	-	16.2	17.2	22.0	-	-	-
Fuel Cells	1.0	45.6	52.7	49.2	39.2	44.2	37.6	6.4	8.5	11.6	-	-	-
Gas-to-Liquids	-	6.2	6.8	5.3	6.2	6.8	5.3	-	-	-	-	-	-
Low-Quality Gas Upgrade	-	1.1	1.9	1.6	1.1	1.9	1.6	-	-	-	-	-	-
Int'l Center Gas Tech.	-	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	-
Materials Techs	-	6.9	11.2	11.6	-	-	-	6.9	11.2	11.6	-	-	-
Other	7.0	6.4	7.9	15.0	-	-	-	6.2	7.9	15.0	0.2	-	-
Environmental/ Regulatory Impact	18.6	4.2	4.0	2.6	3.2	3.0	2.6	-	-	-	1.0	1.0	-
Other - GRI only (processing/ resource base crosscut)	8.0	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	114.5	206.7	236.6	219.2	108.5	115.1	105.1	84.9	110.2	106.8	13.3	11.3	7.3

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST
 FOSSIL ENERGY RESEARCH AND DEVELOPMENT
 FOSSIL ENERGY
 FACILITIES SUMMARY
 Advanced Clean/Efficient Power Systems

Facility	Description	Location	Ownership-Title Vested in		Investment Thru		Funding Support Estimate (\$M)					
					FY 1998 (\$M)		FY 1999		FY 2000			
	Capability		Gov't Agency	Other	R&D	Capital	R&D	Capital	R&D	Capital		
					Industry Government	Industry Government	Industry Government	Industry Government	Industry Government	Industry Government		
EPRI 5 Mwe - in operation	High sulfur test facility	Somerset, NY	DOE owns nothing	Site owned by NYSE&G, eqpt. owned by EPRI	26.0	20.2	0	0	0	0		
					---	---	---	---	---	---		
					10.0	0	0	0	0	0		
FETC Flue Gas Cleanup Research Laboratory 0.75 MWe- in operation	Testing of various advanced technologies for flue gas cleanup	Pittsburgh, PA	DOE (both equipment and site)	N/A	0	0	0	0	0	0		
					---	---	---	---	---	---		
					13.9	0	0.5	0	0.5	0		
Power Systems Development Facility	Flexible transport reactor gas producer, hot gas particulate removal system testing, and 8.0 MWe Advanced PFB System	Wilsonville, AL	DOE owns the majority of the equipment	Southern Co. Services and Consortium owns site	32.4	0	3.9	0	3.9	0		
					---	---	---	---	---	---		
					151.5	0	18.1	0	19.3	0		
PFBC Adv. Concepts	Phase IIIA Testing of 1.6MWe PFBC integrated system at Foster Wheeler's facility. Testing to continue for 2 years.	Livingston, NJ	DOE	Foster-Wheeler owns site	4.9	0	0.1	0	0	0		
					---	---	---	---	---	---		
					44.8	0	0.1	0	0	0		
B&W Systems Development Facility	10 MW combustion facility fully equipped with advanced environmental control technologies	Alliance, OH	DOE owns nothing	B&W owns site	10.0	20.0	0	0	0	0		
					---	---	---	---	---	---		
					5.5	0	0	0	0	0		

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST
 FOSSIL ENERGY RESEARCH AND DEVELOPMENT
 FOSSIL ENERGY
 FACILITIES SUMMARY
 Advanced Clean Fuels Research

Facility	Description	Location	Ownership-Title Vested in		Investment Thru		Funding Support Estimate (\$M)					
					FY 1998 (\$M)		FY 1999		FY 2000			
	Capability		Gov't Agency	Other	R&D	Capital	R&D	Capital	R&D	Capital		
					Industry	Industry	Industry	Industry	Industry	Industry		
			Government	Government	Government	Government	Government	Government	Government			
Gasification Process Evaluation Facility	PDU scale, in operation; 24 TPD fixed-bed gasification with moving bed hot gas desulfurization and turbine simulation	General Electric Corp. Research and Development Center, Schenectady, NY	DOE owns minor equipment	General Electric Corp. owns site and major equipment	16.7	0	0	0	0	0	0	
					---	---	---	---	---	---		
					43.2	0	0	0	0	0		
LaPorte Liquid Phase Alternative Fuels PDU	Proof-of-concept; 35 BPD methanol. 35 BPD equivalent methanol. Unit was upgraded for mixed alcohols operation in spring 1994.	LaPorte, TX	DOE (equipment only)	Air Products owns site	6.9	0	0.4	0	0.4	0		
					---	---	---	---	---	---		
					55.7	0	1.0	0	1.0	0		
Syn Gas Generator and transport reactor fluid bed hot gas desulfurization PDU	PDU to provide up to 150,000 SCFH dirty gas to test advanced hot gas cleanup devices in FETC PDU	Federal Energy Technology Center, Morgantown, WV	DOE Office of Fossil Energy	---	0	0	0	0	0	0		
					---	---	---	---	---	---		
					25.7	0	3.1	0	3.0	0		

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST
 FOSSIL ENERGY

TOTAL STAFFING SUMMARY
 DISTRIBUTION OF FTE'S
 OFFICE OF FOSSIL ENERGY
 SUMMARY

	Full-Time Equivalents		
	FY 1998 Actual	FY 1999 Request	FY 2000 Request
Fossil Energy Research and Development	579	594	582
Headquarters	116	116	116
National Petroleum Technology Office	25	23	27
Federal Energy Technology Center - Morgantown	205	214	206
Federal Energy Technology Center - Pittsburgh	233	241	233
Clean Coal Technology	61	67	60
Headquarters	18	18	17
Federal Energy Technology Center - Morgantown	17	23	20
Federal Energy Technology Center - Pittsburgh	26	26	23
Naval Petroleum and Oil Shale Reserves	53	41	39
Headquarters	16	15	12
Casper Naval Petroleum and Oil Shale Reserves	18	20	22
Elk Hills Naval Petroleum and Oil Shale Reserves	19	6	5
Strategic Petroleum Reserve	132	135	125
Headquarters	29	25	25
Project Management Office	103	110	100
Mining Research and Development	81	85	85
Bureau of Mines - FETC (Pittsburgh)	0	0	14
 Total	 906	 922	 905

DEPARTMENT OF ENERGY
 FY 2000 CONGRESSIONAL BUDGET REQUEST
 FOSSIL ENERGY

DISTRIBUTION OF FTE'S
 FOSSIL ENERGY RESEARCH AND DEVELOPMENT
 SUMMARY

	Full-Time Equivalents		
	<u>FY 1998</u> <u>Request</u>	<u>FY 1999</u> <u>Request</u>	<u>FY 2000</u> <u>Request</u>
Advanced Clean Fuels Research	33	33	33
Advanced Clean/Efficient Power Systems	83	99	83
Advanced Research and Technology Development	11	11	11
Natural Gas Research	24	24	24
Program Direction	409	408	412
Fuels Program	19	19	19
Mining Research and Development	81	85	85
Bureau of Mines - FETC (Pittsburgh)	<u>0</u>	<u>0</u>	<u>14</u>
 Total	 660	 679	 681

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
HEADQUARTERS

	Full-Time Equivalents		
	<u>FY 1998</u> <u>Request</u>	<u>FY 1999</u> <u>Request</u>	<u>FY 2000</u> <u>Request</u>
Program Direction	97	97	97
Fuels Program	19	19	19
Total	116	116	116

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
FEDERAL ENERGY TECHNOLOGY CENTER - MORGANTOWN

	Full-Time Equivalents		
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
	<u>Request</u>	<u>Request</u>	<u>Request</u>
Advanced Clean/Efficient Power Systems	36	44	36
Advanced Research and Technology Development	11	11	11
Natural Gas Research	24	24	24
Program Direction	<u>134</u>	<u>135</u>	<u>135</u>
Total	205	214	206

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
FEDERAL ENERGY TECHNOLOGY CENTER - PITTSBURGH

	Full-Time Equivalents		
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
	<u>Request</u>	<u>Request</u>	<u>Request</u>
Advanced Clean Fuels Research	33	33	33
Advanced Clean/Efficient Power Systems	47	55	47
Program Direction	<u>153</u>	<u>153</u>	<u>153</u>
Total	233	241	233

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
NATIONAL PETROLEUM TECHNOLOGY OFFICE

	Full-Time Equivalents		
	<u>FY 1998 Request</u>	<u>FY 1999 Request</u>	<u>FY 2000 Request</u>
Program Direction	<u>25</u>	<u>23</u>	<u>27</u>
Total	25	23	27

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
CLEAN COAL TECHNOLOGY

	Full-Time Equivalents		
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
	<u>Request</u>	<u>Request</u>	<u>Request</u>
Headquarters	18	18	17
Federal Energy Technology Center - Morgantown	17	23	20
Federal Energy Technology Center - Pittsburgh	26	26	23
Total	61	67	60

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
STRATEGIC PETROLEUM RESERVE

	Full-Time Equivalents		
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
	<u>Request</u>	<u>Request</u>	<u>Request</u>
Headquarters	29	25	25
Project Management Office	<u>103</u>	<u>110</u>	<u>100</u>
Total	132	135	125

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
NAVAL PETROLEUM AND OIL SHALE RESERVES

	Full-Time Equivalents		
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
	<u>Request</u>	<u>Request</u>	<u>Request</u>
Headquarters	16	15	12
Casper Naval Petroleum and Oil Shale Reserves	18	20	22
Elk Hills Naval Petroleum and Oil Shale Reserves	19	6	5
Total	53	41	39

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
BUREAU OF MINES - FETC (Pittsburgh)

	Full-Time Equivalents		
	<u>FY 1998</u> <u>Request</u>	<u>FY 1999</u> <u>Request</u>	<u>FY 2000</u> <u>Request</u>
Bureau of Mines - FETC (Pittsburgh)	<u>0</u>	<u>0</u>	<u>14</u>
Total	0	0	14

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY

DISTRIBUTION OF FTE'S
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
MINING RESEARCH AND DEVELOPMENT

	Full-Time Equivalents		
	<u>FY 1998 Request</u>	<u>FY 1999 Request</u>	<u>FY 2000 Request</u>
Mining Research and Development	<u>81</u>	<u>85</u>	<u>85</u>
Total	81	85	85